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CONTENTS.

EDITORIAL:
Electrical Terms . . . 809
Misapplied Methods . . . 809
The Engineer's Fee . . . 810
The Possibilities of Electric Traction . . . 810
The Telephone Appreciated . . . 810
The Convention of the National Electric Light Association . . . 811
Predetermination of Sparking in Direct-Current Machines, by W. L. Waters . . . 824
Terrestrial Magnetism . . . 827
The Way to Balance the Plates of a Wimshurst Electrical Machine, by John M. Blake . . . 827
Massachusetts Institute of Technology . . . 827
A Large, Modern Paris Generating Plant, by C. L. Durand . . . 828
The Faraday Society . . . 832
Gutta-Percha in the Philippines . . . 832
A One-Hundred-Mile Transmission Line, by Robert Howes . . . 833
A Three-Wire Five-Hundred-Volt Lighting System, by Walter I. Barnes . . . 836
Data and Tests on a 10,000 Cycle per Second Alternator, by B. G. Lamme . . . 839
An Automatic Gas Pump . . . 841
The New Signaling System at the Consolidated Exchange, New York City . . . 842
Electrical Namenclature . . . 843
Fort Wayne Series Alternating System of Street Arc Lighting . . . 844
To Welcome Foreign Electrical Engineers . . . 844
Electrical Patents . . . 845
Water Power in Germany . . . 845
Cable Cutting . . . 845
REVIEWS OF CURRENT ENGINEERING AND SCIENTIFIC LITERATURE . . . 846
The National Contractors' Association . . . 847
INDUSTRIAL SECTION:
The Shaw Non-Arcing Lightning Arrester . . . 848
A Device for Saving Cylinder Oil . . . 848
Walker Magnetic Chuck . . . 849
The Frost Storage Battery Grid . . . 850
Protection for a Large and Expensive Power Plant . . . 850
CURRENT ELECTRICAL NEWS . . . 851

ELECTRICAL TERMS.

Our esteemed contemporary, the London *Electrician,* in some remarks about the inventive genius of the American engineer in devising uncouth names, says that the term "booster" is coming into general use in England, despite strong protest. When this machine is used in the reverse sense for lowering the potential, instead of raising it, in England they call it a "negative booster." Over here, the *Electrician* says, we are ready with the "short, sweet and expressive title crusher." Perhaps a better word could be found, but, in any case, "crusher" is expressive, for it indicates clearly the purpose for which the machine is used, and does not approach the subject indirectly as does "negative booster."

MISAPPLIED METHODS.

The old saw "a little knowledge is a dangerous thing" is applicable to that class of inventors which has become imbued with the idea that because a certain type of apparatus has brought about a revolution in one particular application, it offers a general solution for all problems showing the slightest resemblance to that one. These men may be, and often are, thoroughly versed in their own line of work, knowing it down to the smallest detail, but as soon as they go outside of this they tread on dangerous ground. Thus, to get the occupants of a skyscraper to their offices, or the coal for a power station to the hoppers, both must be lifted, but there the similarity ends and no one with any knowledge of the requirements of the two cases would think of applying the same method to both.

How Mistakes Are Made.

This type of inventor is too sanguine. He overlooks the practical difficulties hedging him about on every side and sees only a pretty result in the distance. For instance, the ideal automobile would be one driven by an electric motor which draws its power from a really cheap and good primary battery. Hence we read, not long since, of such a primary battery invented by an enthusiastic automobilist whose experience with electricity had not probably reached beyond his electric igniter, and who presumably knew nothing about chemistry. Again, by means of the electric furnace metals previously expensive are produced commercially, but it does not follow from this that the days of the blast furnace are over, as some would have us believe. Fortunately, the limitations in this direction, set by present conditions, are recognized, and the proper use of electricity in the production of iron and steel and other metals is being studied carefully with excellent results.

An Instance of Misdirected Effort.

An instance of this misdirected effort was made public in a recent description of an electrical method of propelling vessels. The usual equipment of one, two or three propellers, each driven by a steam engine, was to be replaced by series of smaller propellers, each driven at a high speed by an electric motor. These propellers were to be arranged along the sides of the vessel so as not to interfere with each other. This arrangement was thought to be advantageous, since the many small propellers would act on a wider belt of water and the higher speed at which they would be run would, according to the inventor, result in a higher speed of the vessel. It was said that the present type of reciprocating engine was limited, as regards speed, to 150 revolutions per minute, while the motors could run at 1,500 revolutions per minute. The relation between the pitch of the propeller blades and their angular velocity counted for nothing, and cavitation apparently was not dreamed

of. The idea evidently was suggested by current electric railway practice, where motors are placed at several points of the train. The efficacy of the many small propellers can best be determined by experimentation; but why the roundabout way of driving these? Why drive, by means of an engine, a generator which will itself drive the motors, they in turn driving the propellers? Why not drive each propeller directly by a suitable engine since the peculiar characteristics of the electric motor do not seem necessary here? The steam turbine runs at a high enough speed—too high in fact—but this could be reduced by connecting two or more in series. This would eliminate the main driving engine and generator besides avoiding the losses which would take place in these. But this simplification brings us practically to what is now being tried on small vessels and will soon be tested on large ones, so that it does not appear that our inventor has really accomplished anything. It is never safe to assume that because a particular problem has been solved successfully in a certain way that this same method will be equally applicable in another somewhat similar problem. Before one is justified in going ahead, he should first determine fully the requirements of the one case and understand thoroughly why the method was successful in the other.

THE ENGINEER'S FEE.

Our esteemed contemporary, the *Engineering News*, publishes the following schedule of charges, reprinted from the letterhead of a firm of consulting engineers in New York city.

SCHEDULE OF CHARGES.

Full professional services, including active superintendence and management	10	per cent.
Full professional services, including general supervision	5	"
Preliminary study	1	"
Preliminary study, general drawings and specifications	2½	"
Preliminary study, detailed drawings and specifications	3½	"

Commission computed upon entire cost of the work. Traveling expenses to be paid by time.

Our contemporary then makes the very pertinent remark: "perhaps if more engineers made a practice of boldly advertising their scale of charges in some such manner, it would tend to raise the standard of the profession. People are apt to value things in proportion to what they pay for them, and if they buy engineering services at about the same per diem rate that they pay a trade union workman, they are quite likely to underestimate the importance of the actual value of the engineer's work."

Every engineer should stand on the dignity of his profession. His fees should be stated clearly and boldly, and no suggestion of a reduction should be entertained.

THE POSSIBILITIES OF ELECTRIC TRACTION.

Improvements in railway service, made possible by the adoption of electric traction, are demonstrated by the performance of the elevated lines in New York city for the year ending with last February. The conversion of these lines from steam to electricity, begun two years ago (the formal opening of electric traction on the elevated system took place on January 9, 1902, on the Second Avenue line), was not completed until last year, when the steam locomotives were taken off the Ninth Avenue line. For this reason, a comparison of the performance of these lines last year and the year previous does not show the entire gain made by the use of longer trains and a faster schedule. The gain, however, was remarkable. The number of passengers carried during last year—that is, the year ending with February, 1904—was 273,133,242, an increase of 37,318,852 over the preceding year. The total car mileage for the same period was 60,730,337, an increase of 12,870,859. Expressed in percentages, the increase in the number of passengers was 15.85 per cent, and the increase in the mileage was 26.9 per cent. It will be seen that the increase in traffic has not kept pace with the increase in car-mile, but this is due, no doubt, to the better service which is now furnished during the hours of light traffic.

THE TELEPHONE APPRECIATED.

As an example of the density of telephone installations among householders as well as business establishments, the secretary of a neighborhood club of thirty-five members, at Lynn, Mass., recently received information over the telephone announcing the sudden death of one of their number, and this required that information of the postponement of a meeting of the club appointed for the next evening should be at once promulgated to the members.

On consulting the telephone directory, it was found that twenty-eight of the thirty-five members were provided with telephones at their homes, and the remainder had them at their places of business, and all of those who were in business at Lynn or Boston had telephones at their offices.

That is, among the thirty-five members, there were twenty-eight residential telephone and thirty-two business telephones, making sixty telephones at the service of these thirty-five persons, eight of whom had private branch exchanges at their places of business.

In the evening, the secretary communicated to the twenty-eight residences the information of the death, and gave notice of the postponement of the meeting, also answering numerous questions which the notice evoked, making in all thirty-two calls; as four of the lines were reported busy, second calls were made later, and these persons were notified during the short space of thirty minutes.

All except four of the 103 members of a golf club at Chestnut Hill can be reached by telephone; seventy-eight having telephones at their residences, and eighty-three at their places of business, making a total of 161 telephones for these 103 people. As nine of these members are single women, students or retired, so that they have no business, the relative business density of telephone installations is eighty-three out of a possible ninety-four.

As the telephone began as a business luxury, available only to those of large commercial affairs, its later development has extended to residences, smaller stores, and to isolated houses in sparsely settled districts, particularly the homes of farmers, being especially useful to them, while it will still continue to ameliorate the condition of the rich.

Is it not evident that the excellence of this telephone service was a prominent factor in securing the large number of subscribers which this occurrence indicates?

The National Electric Light Association.

The Twenty-seventh Convention, Held in Boston, May 24, 25, 26, 27.

TUESDAY MORNING SESSION.

President Charles L. Edgar, of Boston, called the meeting to order at 10.45 o'clock and said: "I take great pleasure in calling the twenty-seventh annual convention of the National Electric Light Association to order. The first business in order will be the reading of acceptances of invitations to attend this meeting and letters of regret at not being able to do so, from various gentlemen, both past-presidents, honorary members and distinguished gentlemen whom we have invited to attend.

The secretary then read letters from the following gentlemen, who indicated their intention of attending the convention: Professor Louis Duncan, Massachusetts Institute of Technology; F. P. Fish, American Telephone and Telegraph Company, Boston; Professor Hollis, Harvard University; Professor Hooper, Tufts College; President Henry S. Pritchett, Massachusetts Institute of Technology; Professor A. E. Kennelly, Harvard University; Frederic Nicholls, past-president, of Toronto; Thomas D. Lockwood, American Telephone and Telegraph Company, Boston.

Letters and telegrams of regret at not being able to attend were received from the following: Charles R. Huntley, Buffalo; Thomas A. Edison, Orange, N. J.; W. L. Bowers, Davenport, Iowa; J. W. Lieb, Jr., New York; S. B. Livermore, Winona, Minn.; Samuel Insull, London, England; C. L. Wakefield, Dallas, Tex.; C. H. Wilmerding, Chicago, Ill.; S. A. Duncan, Atlanta, Ga.; E. A. Armstrong, Camden, N. J.; M. J. Francisco, Rutland, Vt.; A. M. Young, Waterbury, Ct.; E. L. Nichols, Cornell University; C. O. Baker, New York; George S. Bowen, Chicago; Charles F. Brush, Cleveland.

President Edgar made the annual address, saying in part:

The number of electric light stations has increased during these seventeen years more than nine-fold. Naturally the membership of this association has not grown in proportion, but the fact that there are now upon our rolls five hundred and eighty-eight members, as compared with only one hundred and fifty-eight at that time, is a matter for sincere congratulations. The work done by my two immediate predecessors in getting new members into the association stands by itself. The growth this year, as the result of their work, has been rather slow. At the same time, the association has had a healthy and steady increase in membership, and I feel satisfied that it will continue in at least as great a ratio as during the past year. . . . The time has come when it seems desirable to make a change in the by-laws of your association. When it was organized some nineteen years ago the industry consisted of a large number of small companies, located throughout the country. Almost without exception, these companies were confined each to its own city; in fact, there were a number of cities, especially those of the larger size, that had a number of competing companies. As time went on, consolidations took place, either by the purchase of a local company by a syndicate or holding company or by the actual amalgamation either of competing or of adjoining companies. This has, at the present time, been carried on to such an extent that in some sections of the country all of the small companies have now been obliterated, and one large corporation now covers the territory and does the entire work. A most striking example of this kind comes under my own personal observation. The Boston Edison Company has taken the place of fifteen local lighting companies, all of whom were eligible for membership in our association. Under the regulations of this state, it is necessary to actually wind up these local companies, not only in business, but in a corporate sense, and a number of them have therefore had to resign from the association. Within the next year or two there will be only one company left and the actual membership in the association will be cut down from seven to one. This is going on all over the country, and is a matter of serious concern for the future of the association. The matter has been discussed at considerable length by the executive committee, and numerous suggestions have been made for overcoming the difficulty. These have been put in concrete form by your secretary and will be submitted to the association in executive session. Speaking generally, the remedy suggested is to have another class

MR C. H. DAVIS, PRESIDENT-ELECT OF THE NATIONAL ELECTRIC LIGHT ASSOCIATION.

of membership, consisting of individuals called junior active members, to be elected under some sort of supervision of the active member with whom they are connected in business and paying as dues an amount in keeping with their privileges. I trust that this matter will be given serious consideration by the members of the association within the next two or three days, so that a conclusion can be arrived at at the executive session on Thursday.

The electric lighting industry in this country has in the past, in certain definite directions, been under somewhat serious disadvantages because of a lack of a comprehensive and correct directory of our industry. In most other lines of work it has been possible for manufacturers, investors or enquirers generally to find out something about the industry in which they were interested. This want was brought especially to my attention some time during the early part of the year. One of the various circulars issued periodically by our assistant secretary was sent out over my name and mailed from Boston. The number of letters returned to me undelivered was astonishing, and I came to the conclusion that all the existing lists were worse than useless. About this time our attention was called to the prospect of this work being taken up by one of our own members and put on a par with the publications of other industries of like character. I think that we should give our earnest support to this enterprise; incidentally, because it is carried on by one of our own members, but primarily and selfishly because we are interested in having it a success.

Mr. Edgar referred to the proposed union engineering building, and suggested locating the permanent offices of the National Electric Light Association in this building. He referred to the matter of accepting a new invitation from the International Electrical Congress, to send three papers and a delegate to St. Louis. Both at the Cincinnati convention and at Chicago invitations had been extended to the association to meet at St. Louis and take part in the congress. Unfortunately, this invitation was overlooked in making up the final programme. Mr. Edgar called attention to the programme and the efforts which the entertainment committee had made to render this attractive to the members. He called upon the members who took part in the discussion to make every effort to correct their statements before leaving Boston, in order that an absolutely correct report of the proceedings could be had immediately after the convention, and directed attention to the question box and "wrinkles." The gold medal offered two years ago by Past-President Doherty for the best paper on underground systems, he said, was not awarded last year. In February of this year notices were sent out to members of the association and to the public generally, that the competition was open. A number of papers had been presented and considered by a committee of three distinguished engineers. A conclusion had been arrived at, and this would be announced at the next morning's session. Mr. Edgar called attention to the new use which had been made of electricity during the especially cold weather of the past winter. This was in the thawing of water pipes. He had been disappointed in getting a paper on this subject, and suggested the appointment of a reporter to take up this matter and compile such information as could be obtained concerning the recent experiences of the member companies.

Mr. Henry L. Doherty, Denver, moved that the secretary be instructed to appoint a committee of three to consider and report upon the recommendations in the president's address. Carried. The secretary subsequently appointed as such committee Henry L. Doherty, Denver, chairman; George W. Brine, Atlanta; H. T. Hartman, Philadelphia.

Mr. T. C. Martin presented the report of the Committee on "Progress."

The president called upon Mr. Edwin J. Weeks, of Kansas City, to address the session. He said:

"Much could be said of the advantages of membership in this association; but it

is rather of the greater good accruing from our associated efforts to the engineering professions and to the world at large that I am reminded on this occasion. Modern electrical researches and investigations, furthered in many ways by the work and by the influence of this association, have given a quickening impulse to all trades and professions, and have created an intellectual expansion without parallel in history. This association is not yet of age; but its lines have fallen in stirring times and in places where much honor was to be won. Its older members reviewing the early trials and brilliant achievements of almost the entire field of applied electricity, may say 'all of this we saw, much of this we were'; and its younger members may face the future with the certainty of still wider commercial applications and the necessity for higher professional attainments. The electrical industries still lead the van of human progress. The electrical engineer, in the highest sense of the word, is the resultant of all engineering experience, and to the engineers of the world, if I may include inventors as engineers, more than to all other professions combined, the civilization of the present day is due. This association is to be congratulated on its growth and influence. The first session of this meeting, in its unusually large attendance, is certainly a great compliment to our honored president, Mr. Edgar."

After some discussion of the "Progress" report, the paper "A Three-Wire, 500-Volt Lighting System" was read by the author, Mr. Walter I. Barnes, Providence, R. I.

This paper is mainly a description of the system of the Narragansett Electric Lighting Company, and takes up in detail the necessities for the installation and the method of taking up the different elements and perfecting the complete system. This paper will be found on another page of this issue.

Mr. G. H. Whitfield, Richmond, Va.—Mr. Barnes mentions that some of the buildings were rewired. Did the company pay for that or did the consumer?

Mr. Woodward—In our first installations the company assumed the expense; in the installations being made at the present time the consumer bears the burden.

Mr. P. Junkersfeld, Chicago—I believe it would have been a good thing if more could have been heard about the operating feature of the system; particularly as concerns the difference in the loss in the 250-500-volt and the 125-250-volt systems. In the incandescent lamp system there is a considerable difference in energy loss. The statement is made that it gets 3.3 watts with 4,000 hours, and even that makes a considerable difference. The arc-lamp situation is more serious. The loss amounts to a very considerable sum in the course of a year, and this energy is a finished product, delivered at the customer's premises, and if the company can market the energy, it is worth whatever its average income is per kilowatt-hour of energy. Another item of loss is meter loss. These are made double. In place of the ordinary six watts loss per meter, shunt losses, there are twelve watts lost, due to the doubling of the voltage. The meter slip, in the course of a year, also amounts to a very considerable item. All of these things are offset, it is suggested, by the difference in the investment required. Whether or not that is true, in part or as a whole, is a matter for individual consideration. Each individual case must be considered by itself. I would make this point, however, that it is a pretty well established fact in large cities, or cities scattered over considerable area, that with the lower voltage system four substations require about the same feeder copper as one substation of this size. That difference in investment is, then, largely a question of individual conditions, and if the load is quite dense in practice you can do better, because you can establish the substations nearer to the dense portions. While the system has many things in its favor, it must be taken up carefully, and even under circumstances where it will apply the alternating system is a serious competitor.

Mr. Alex Dow, Detroit—I wish to ask a question, which is incidental to the practice described in the paper, although not controlled by the 200-volt feature of the distribution. Mr. Barnes indicates that at least in one installation on the outside the neutral is earthed on the customer's premises. It seems to be his intention to earth the neutral on the customer's premises wherever permitted to do so. He describes the installation as having a copper neutral riser, but the neutral is bonded to the pipe system. I should anticipate in a town where there is a street-car system that the establishing of earth at different points at the lagging distribution would cause a considerable flow of street railway returns over the neutral wires of the lighting system. That flow may be very large. Frequently, in my experience, it is insufficient to disturb the regulation, but at times it is so large as to seriously heat the conductors. A case which has come under my observation is that of two earths made on the neutral of the three-wire system, about 8,000 feet apart, where, during the evening peak of the street-railway load, there is a maintained difference of potential of ten volts. In that particular instance it merely disturbs the regulation very seriously, and causes unbalancing of the three-wire system, and necessitates special provision being made for balancing at different points. It may, however, cause not merely unbalancing and disturbance to the lighting, but serious heating.

Mr. Woodward—I will answer the last speaker first, in regard to the neutral current, and will say that the lead sheaths of all our cables are bonded together in every manhole, and in every manhole there is a ground plate which is bonded to the sheaths and to neutral, so that we have a dead continuous copper neutral, and a continuous dead neutral, all of which are bonded together and to the earth; and in several years of operation we have found but one section of the city—and that was very near to a point where the railway cables crossed the river—where we have any disturbance, or our lead sheath has suffered to any extent. Tests have been made at different portions of the city, and little or no current has been detected. I will take up some of the portions mentioned by a former critic on the subject, and first refer to the question of meter slip. I understand by "slip" that the gentlemen meant the unaccounted-for meter current. I fail to see how there would be any more slip under a 500-volt meter than there is on a 250-volt meter. The matter of shunt current can be definitely determined, and why the meter should be any more inaccurate or give rise to any more unaccounted-for losses, I can not see. The question of the arc lamp—the arc-lamp situation on 104 volts, direct or alternating current, is not perfect. We all look for a better lamp. We look for a lamp which is more economical. I will confess that the lamp operated at 250 volts is not so good as one operated at 104 volts; but, nevertheless, it has been quite satisfactory. In reference to the substations—when it is considered that a single substation at 250-500-volt three-wire system will cover sixteen times the area that could be supplied from a substation operated at 104-208, or 125-250-volt, it would seem that the system using the higher voltage, three-wire, would be in greater favor. Taking the relative values of the alternating and direct current—when you consider all classes of motors to be supplied, all classes of lighting, I fail to see how you can serve it with the alternating current at all times, when you surely can with the direct current. I do not know of a single central station supplying a large area, where they have variable-speed motors, which has been successfully covered by the alternating current.

Mr. Arthur Williams, New York—May I ask how the insurance questions have been settled; whether Mr. Woodward has any objection to speaking about the insurance on the Union Trust building, which has been wired without the neutral on the secondary?

Mr. Henry L. Doherty, Denver—There is one point I would wish to have covered. Mr. Woodward says he fails to see where a continuous slip would come in on the meter on the higher voltage. The torque on the motor is proportional to the amperage, and as you are supplying current at higher amperage, the slip would be twice as much on a commutated meter as on a series meter. As an example of what shunt losses may mean, I might cite one of our neutral alternating-current circuits at Madison, where the shunt-meter losses amount to more than the core losses of the transformers.

Mr. P. G. Gossler, New York—I notice that the instance given of the wiring of the Union Trust Company's building, that all the taps are single wire, the

metal pipe system of the building being used as a neutral conductor, I would ask what the practice is in those buildings which do not have metallic frames? Is the piping system relied on entirely for the neutral return for the ground?

Mr. Woodward—By no means; but we take the piping system of an old installation and wire on that. A rewire installation, a revamped installation, would have a neutral copper as the third wire in the three-wire system, and as the secondary wire in all branch circuits. The building cited was a new building and the wires were connected in this manner more as an experiment than anything else. In answer to Mr. Williams's question on the insurance point, the subject was brought up to the insurance people and talked over with them, its varied phases were considered, and it was not until we had a real heart-to-heart talk and had threshed out to their satisfaction and our own all the points brought up—it was not until that time that the system was put in operation. The insurance companies have made no adverse comments from that time to the present time.

Mr. E. V. Matlack, St. Louis—We have a system in St. Louis somewhat similar to this, except our three-wire is 240-480 volts. Our neutral is the lead sheath of the cable, nothing else, two-wire cable, and in the house we carry a three-wire the same as is usually done, but we have no junction box in our manholes in the underground system. And the lead sheathing is the only neutral. We have had no trouble, and have operated the system successfully for the last three years.

The next paper was read by Mr. Welles E. Holmes, of Newton, Mass., on "The Luminous or Flaming Arc."

This paper discusses a system of lighting by the use of a new and improved arc lamp lately brought out by the General Electric Company, of Schenectady, N. Y. A description is given of the lamp, the generator and the results of actual commercial conditions of operation of thirty of these lamps in connection with the plant of the Newton & Watertown Gas Light Company for about six months. Although an open arc, the lamp is a long-burning lamp, the electrodes having a life of about 150 hours. The magnetite stick which forms the lower and negative electrode of the lamp is the invention of Dr. C. P. Steinmetz. This stick is made of magnetite, but may be compounded with other substances to obtain a desired result. Experiments have been made with differently compounded sticks, some of them being solid like a section of steel rod, and others being made by enclosing powdered magnetite in a thin iron sheath. A filled stick, or a stick made by filling a sheath with the magnetite compound, has given the best results. The action of the lamp is as follows: when started, a pick-up magnet draws the magnetite stick up until it strikes a cast-copper segment. It immediately falls away to its burning position, about one inch below the copper, at the same time drawing its arc. The striking segment draws away, and a burning segment takes its place, the arc following from one segment to the other. In the action of changing segments, the arc is not interrupted, as the distance between the magnetite electrode and these segments is maintained the same by reason of the segments swinging in the arc of a circle. The lamp burns with an arc about one inch long, and a thin smoke is given off by the magnetite electrode, the smoke being taken care of by a chimney occupying the central portion of the lamp. The lower opening of this chimney is immediately over the arc, the top of the chimney being open to the air and provided with a proper rain-shield.

Mr. Holmes said that as to the dust or coating on the globe—the holes in the globes which were first used were on the side, so that when the wind blew through the holes it caused the copper dust to collect on the globe. From experience it has been concluded the lamp needs a strictly upward draft and in the next globes the globe opening was indented, and holes drilled in the indented portion so that the side wind could not be blown into the globe pan, but must come up from the bottom, and that has remedied the difficulty which was first experienced in the coating of the globe with the red oxide.

Mr. W. H. Cole, Newton, Mass.—I ask how the globe and the light, as regards color—how it has been affected by the different experiments on the magnetite composition? That is, although Mr. Holmes's last remark perhaps touched upon that—the light at present being the nearest approach to sunlight in the arc lamp—but I want to know to what extent that quality is variable in the composition of the magnetite stick?

Mr. Holmes—That effect is dependent upon the composition of the magnetite stick. Those of you who were at the convention of the Association of Edison Illuminating Companies at the Thousand Islands saw Dr. Steinmetz vary the color of the magnetite sticks by different compositions. It is possible to vary the color of the rays of light in this lamp by different compounds in the composition of the stick. The General Electric Company is experimenting on this subject to give us a stick which will come as near producing daylight as possible.

Mr. W. H. Cole—To what extent is the lamp affected on very windy nights as compared with calm nights? The fact of the pan being perforated, necessarily, in order to give an upward draft—to what extent is that draft affected on very windy, stormy nights, particularly windy nights?

Mr. Holmes—With the globe pan we now have, we have no trouble that way—the difference between a windy and a calm night not being noticeable to us. Before we had the present globe pan we were troubled by the lamp kicking or humming a great deal, caused by the draft making the arc unsteady and cutting out.

On motion, the meeting adjourned until 2.30 P. M.

TUESDAY AFTERNOON SESSION.

President Edgar called the meeting to order at 2.30 o'clock, when the session took up the consideration of the reports of the four committees which were left over from the morning session. The committee on "Uniform Accounting," of which Mr. Guy L. Tripp, of Boston, was chairman, had nothing further to report, and upon motion of Mr. W. M. Anthony, Chicago, was discharged. The committee on "Legislative Policy" was also discharged.

The paper "A One Hundred Mile Transmission Line," by Mr. Robert Howes, Spokane, Wash., was then read.

This paper was a description of the plant of the Washington Water Power Company, of Spokane, Wash. The power-house is located on the lower falls of the Spokane river, with a theoretical head on the water-wheels of seventy-one feet. The plant operates at 4,000 volts, and the revolving-field alternators are direct-driven from a pair of forty and one-half inch special turbines. This article has been reproduced in full on another page of this issue.

After reading the paper Mr. Howes said that since this paper was written he had received the regulator and got it installed in time for him to know the results before he left Spokane. He had succeeded in holding the voltage at Spokane practically steady. There was a variation not to exceed three-quarters of a volt above or below the normal on a 116-volt basis. At the other end of the line this cut down one-half of what it was before. Then the controller for the motor arrived, but without a time relay device. When that was installed he cut down the variation at the other end to one-half of what it was then, leaving it with a variation of one-quarter at the other end of the line to what it was when he wrote this paper. He had variations of five to six per cent on either end of the line in extreme cases.

Mr. Kelsch, Montreal—How many times has it been necessary to shut down this high-tension transmission line to make repairs or any other changes in addition to the seven times in the eight months which have been referred to?

Mr. Howes—The power has never been cut off except to cut in the substations. We made the best of our time while we cut in these seven substations after we started—each time we shut down we made use of the time to renew any insulators found broken, caused by boys throwing stones or shooting small calibre rifles at them. They were contemplating one more shut-down as I was leaving, and it has prob-

ably been made by this time, but we have not made any shutdown for any other purpose since that time.

Mr. P. G. Gossler, New York—I notice that you refer to having three banks of lightning arresters operated, one at the end of the line, one at Spokane, and one about twenty miles from the end of the line. Have you had any lightning storms since the line is in operation, and if so, what has been the effect on the line, also, what has been the amount of transmission at the time of the storms, if any?

Mr. Howes—A day or so before I left there was quite a severe storm. We never have such severe storms as in the East or in the middle states, but we have had a number without any effect whatever. The last storm punctured the insulation on a current transformer for operating the high-tension circuit-breakers in the substations and caused a shutdown of fifteen minutes.

Dr. Louis Bell, Boston—Mr. Howes's experience with that big induction motor at the end of the line is one which should be carefully borne in mind by every one running a big transmission system, for this reason—for some reason, a psychological reason inexplicable to me—people expect of induction motors a degree of immunity from troubles produced on the line and from other ills that motors are heir to which are quite different from anything we have been led to expect with continuous-current motors. A big motor of that kind is bound to make trouble unless the starting rheostat is laid out with an understanding of every possible trouble which may come to it. If it is laid out on general principles, as a rheostat might, could, or should be laid out, if the motor is going to some unknown place, and the motor is put on the end of a 100-mile line, it is almost certain there will be constant trouble from it, for the simple reason that the lower steps of the starting rheostats are not, in three cases out of four, made for the fine gradations that are necessary. Mr. Howes has found it necessary to make an emergency supply or regulator for just that purpose, so that in every case of dealing with this induction motor at the end of a long line, particularly big induction motors, and all big ones are slow-speed motors, in which the power-factor is liable to be low at times, it seems to be a matter of prime necessity to get at the question of the rheostat and look at it with some intelligence and care as in the case of a continuous-current motor of the same rating. Under these circumstances, relatively little trouble will be encountered from these big motors. Corresponding to the conditions of regulation imposed by that unfortunate rheostat, comes the question of the power-factor of the circuit, and it is worth while calling attention to that unity power-factor as a point where the system becomes a bit hypersensitive. I believe one can do better by running a little under the unity power-factor all the time, never giving the current a chance to cross and become leading current. The big induction motors are known to have a steadying property, and if the steadying property is neutralized so as to afford, except for the moment of starting on an empty line, passing to a negative power-factor, so to speak, passing on to the leading current, the chances of oscillating shifts of voltage and chances of troublesome shifts of voltage generally will not be very great.

The report of the committee on "Standard Candle Power of Incandescent Lamps," Dr. Louis Bell, chairman, was taken up.

Dr. Bell—Your committee on the standard rating of incandescent lamps has only a brief verbal report to make before asking for its discharge. The commercial conditions of incandescent lighting have remained fairly stable during the past year—that is, the primary standard lamps are now available from more than one concern, and in general the conditions regarding standardization of lamps have taken a very quiet course, so that it is hardly necessary to comment on that at length or make any extended report. I feel that the work of the committee was pretty much accomplished when the time came that standard lamps could be obtained, and a general understanding was reached as to what would be desirable in the matter of rating and measuring lamps. This being done, your committee asks to be discharged, but in closing I would like to make one recommendation, and that is, in cases of reports of this really technical character, that a closer cooperation of the members of the association is necessary. The members can do a great deal for each other working through a committee than the committee can do for any of them, and the suggestion which your committee has to make is that in cases where work of this kind is to be undertaken, that a proper method of doing it would be to send out to all the members of the association some circular asking for detailed statements of conditions as they find them, and that the answers to these circulars should be digested and passed out as a confidential document so that every member of the association would know what the other members are doing. At a subsequent convention a special or general committee, or some one in charge of the matter, could take hold of the data thus obtained and make a report which every one who had participated in gathering material for it would feel familiar with and could discuss to the best advantage. This is a suggestion thrown out to facilitate the handling of these technical questions.

Upon motion of Mr. Anthony this committee was discharged.

The paper on "Grounding the Neutral of High-Voltage Generators," by Mr. George N. Eastman, of Chicago, was read by the author.

The object of this paper was to present a few conditions which would arise on any alternating-current system, resulting in the production of dangerous potentials relative to earth. The relative potentials between any part of a high-potential alternating-current system and ground will be governed by the distribution of the electrostatic capacity of the line conductors, and the apparatus connected thereto. In general, insulation resistance to ground will have practically no influence on the relative ground potentials. Any condition which will arise on a high-potential alternating-current system which is insulated from earth, disturbing the relation of electrostatic capacities in any part of the system, will affect the ground potentials throughout the entire system. For the purpose of illustration, the author chose a four-wire three-phase system, and described some of the conditions which have led the engineer of the Chicago Edison Company and the Commonwealth Electric Company to permanently ground the neutral of all their high-potential alternating-current generators. Graphics were introduced, and the calculations worked up mathematically. The author believes that the proper manner of grounding the neutral on the generators is through as low a ground resistance as can possibly be obtained, in this manner fixing the maximum potential which can be obtained between the system and the ground at the normal potential which will exist between the neutral of the generator and its phase terminal. The best endorsement of grounding in this manner is the success which has been met with by the Chicago Edison Company and the Commonwealth Electric Company in operating their grounded systems. These systems have been in operation for a period of four years, during which time they have apparently been entirely free from high-potential breakdowns which have been met with by other systems of a similar character which were operated free from ground.

This paper was followed by a paper on the "Remote Control of Electrical Apparatus," by Mr. William H. Cole, of Newton, Mass.

Mr. James I. Ayer, of Cambridge, Mass., read a paper on "Electric Heating."

Mr. F. G. Prout, Memphis, asked, assuming that the suggestions of Mr. Ayer were carried out, what number of dollars per kilowatt of installation might be expected in the way of revenue per year?

Mr. Ayer stated that this was a leading question, difficult to answer. There was an undeveloped field. It is difficult to settle what can be done in the way of expanding business. It is like asking what one can get in dollars and cents by

a new departure in the lighting department. That the output can be added to materially there is no doubt. Electric heating is an attractive thing to customers if it can be made economical. As to the question of methods the output can be added to by adopting the method advocated for arc lamps—installing kitchens free, outfits of everything. There are a number of ways in which one can get results, by applying literally the methods applied to arc lamps. This system is carried out by the gas companies, with great success. Something like $100,000 was invested in gas stoves in and around Boston in one year, which were practically given away.

Mr. Wilcox asked whether Mr. Ayer had any information in regard to the household applications such as cooking, where a complete outfit is put in, as to the demand required, for instance, on a transformer and the load-factor based on that demand?

Mr. Ayer assumed that the average kitchen for the ordinary average family, from four to eight persons, would involve a transformer capacity of about thirty amperes, three kilowatts. The average load-factor is twenty amperes, two kilowatts, at the cooking hour, or about two-thirds of the rate where the electric heating is used only for cooking.

Mr. Wilcox questioned the effect on the part of the load if current for heating and cooking were used all the year round.

Mr. Ayer thought this question could be answered quickly by pointing to the experience of the gas companies in using gas stoves. Except where the comparison is applied to apartment houses, equipped with nothing else but gas stoves, there is practically no winter load with gas stoves. With the apartment house it is a question of rates and method, the two-rate meter, as in cases where one is paid for the peak load; whether the rate with the straight meter will justify them being carried over into the peak load or not, will depend on the value of the service and the increase to your revenue to be gained by this low cost day load. Those are problems which are involved and have much to do with the station handling the question. He doubted if it would be wise to refuse a customer who was going to cook the year round, who would add to his present lighting bill $4 or $5 a month for cooking, where at least ninety-five per cent of the current is used in the daytime, when there was no load, even if the flat rate or the continuous low rate were continued. That is a question for each company to determine. There is a lot of opportunity for laying out theoretical problems and making curves. If the apartment-house customer is secured, he can be carried at a low rate. Most of the load for cooking is over by six o'clock; in other words, the heavy cooking and the demand for current for cooking ceases some little time before the meal is served, and the average meal is served between six and seven, and it is fair to say that at six o'clock, 5.30 o'clock in many kitchens, would see the bulk of the load for cooking going off, because many families are served at six o'clock and one can count on at least the bulk of the load being taken off from fifteen to thirty minutes before the meal is ready to serve.

Mr. Alex. Dow thought the load was a desirable one. The rate might be cut down to a point where there would be considerable business, particularly in apartment houses, and particularly with the large class of people where the mother does the work. But the repair bill is very serious.

Mr. Arthur Williams, New York, said his company has constant applications for just such data as this from contractors and engineers and other people who want to consider electric heating and cooking. Not long ago the company, the New York Edison company, issued a circular, the first edition of which was over 30,000 copies, covering this subject as far as it could in the limits of a small circular, giving the approximate sizes of the utensils, their cost and hourly cost of burning, and another circular which has recently been issued by the company has been called for so generally, that it is evident there is a well sustained and a very widespread public interest in this subject of electric heating and cooking. He thought it will be admitted that electric cooking apparatus will never return to the companies a large revenue, as its use is confined to short periods of the day, but apart from the cooking of the late afternoon dinner-hour in the winter months, whatever revenue comes from this apparatus is additional revenue per kilowatt of installation. In addition, it is one of those factors of convenience and necessity in the supply of electric current for commercial purposes. Take June, July, August and September, any cooking apparatus used in these months can not come on the peak of the system, or of the converters, and it had occurred to him that as residence lighting in these months is very low, why would it not be possible to adopt the English method? A recent English schedule, of which he heard, had come to his notice. That schedule is a half rate for all current consumed below the street level. If the usual rate is twelve cents per kilowatt-hour, the rate for installation below the street level is six cents, and the suggestion occurred to him why they could not in the summer months, for residence lighting, cut the usual rates in two. That might be a way out of the difficulty, because he could see that the installation of the parallel system of wiring, and a second system of meters, or a two-rate meter, would be an application that many companies would not care to indulge in. He knew of a number of instances where small stoves, French coffee-pots, heating pads (than which there is no greater convenience in household arrangements, a substitute for the hot-water bottle), chafing-dishes, and small heaters have been used without any apparent change whatever on the bill. The cost is generally too insignificant to consider, and these costs should be published very generally by the electric lighting companies.

The next paper, "The Organization and Equipment of an Arc Lamp Department," by Mr. Samuel G. Rhodes, New York, was then read.

The data for this paper have been drawn from the experience of the New York Edison Company. The arc-lamp service supplied by this company at present represents a total of 19,300 arc lamps, for both commercial and city lighting. The area within which these 19,300 lamps are installed is thirty-eight square miles. Of the number, 1,740 lamps, within an area of eighteen square miles, are located in the borough of the Bronx, and 17,560, within an area of seventeen square miles, in the borough of Manhattan, the total area of the latter being twenty square miles. The contract department has included in its organization an arc-lighting engineer, and under his direct supervision are the acquisition of new arc-lighting business, the retention of existing installations and the general care of the commercial business connected with this branch of the company's service. The concentration of one class of business in a separate division or department, if of enough magnitude, not only tends to the proper maintenance of the service, but specializes the work and ensures the best results. The specializing not only includes the quality of work, but makes possible economies not obtained under any other form of organization. The trimmer who is responsible for a route with an average of 650 lamps, and of as many as twenty-five different types, must, of necessity, be a better workman than the old open-arc lamp trimmer. With him rests, besides the regularity of the service, the fulfilment of the foreman's ideas on proper maintenance. While a trimmer may be classed as an unskilled workman, time expended in especially training him for his work is well spent.

The report on "Lost and Unaccounted-for Current," by Mr. C. W. Humphrey, Denver, Col., was then taken up.

Most of the data contained in this paper were compiled from results obtained on the lines of the Denver Gas and Electric Company. These lines are now all 2,400-volt single-phase feeders, but the calculations are approximately the same for all systems of distribution, regardless of voltage, frequency or phase. Direct-current losses may be calculated in much the same manner as those of alternating-current circuits, although resistance losses and meter shunt losses are all that must be accounted for. The drop-of-potential method was found the most satisfactory for calculating the line losses. The dif-

ferent losses in the alternating-current system may be classified as follows: transformer iron losses, primary resistance losses, secondary resistance losses, meter shunt losses. In calculating transformer iron losses and keeping records, a card index system, consisting of two sets of cards, is used. One set has a card for each transformer on the lines, and also those in stock, and shows the date of purchase, where set, manufacturer's number and type, the iron and copper losses, as shown by test, and also whether or not the transformer has been removed, and for what cause, as well as a retest on its iron loss before it is again placed in service. These cards show the entire history of each transformer, from the date of purchase up to the present time. The other set of cards, which may be called the feeder index, shows the exact location, make and number of transformer, and also the number of the feeder on which it is located. These cards are arranged according to the location and feeder, while the other index is arranged numerically, according to make and number of the transformer. The methods of making transformer tests are described. A transformer record sheet, for the purpose of more readily finding transformer iron losses, is kept up. These sheets have a line for each day of the month, and on the extreme right of the sheet is a column for the total transformer iron loss for one day of twenty-four hours.

The method of determining the primary resistance loss is described, and curves are given showing the different primary losses obtained with this method. After losses are obtained for a period of one day, the total loss for the month is calculated. This is done by multiplying the output of the feeder for one day by the number of days in the month, and dividing into the total output for the month, as obtained on the feeder watt-meter. This result is squared and multiplied by the losses for one day, and multiplied by the number of days in the month. A meter record sheet is used for meter losses on each feeder. These sheets are kept up from day to day, and at the end of the month the daily losses are summed up, giving the monthly losses. The total sales are figured up at the end of each month.

The company has twenty-four different feeders, on all of which the above records are kept from month to month. These losses have been plotted graphically, showing the variation in losses from month to month, and the gradual but steady decrease in the unknown losses. A table is given of an alternating-current feeder for a period of six months. During that time the feeder was changed from a 1,000-volt individual transformer system to a 2,000-volt, with a three-wire secondary network. This tabulation shows several interesting things. During the first two months the individual transformers were done away with and replaced with the three-wire network, showing a reduction in transformer iron losses from 6,475 kilowatt-hours to 2,560 kilowatt-hours. At the same time, the lost and unaccounted-for current has taken a jump of nearly 170 per cent. The output in sales increased considerably the same month, due to combining another feeder with this one, adding 387 consumers, which were changed over at the same time to a three-wire distribution. In this instance the sales were increased to nearly double the original amount, and the transformer iron loss was decreased to about one-half the original amount. The primary and secondary resistance losses were increased considerably, due to the increase in the output of the feeder. The greater amount of the lost and unaccounted-for current was found to be due to thefts. These were found by systematic inspection of service loops and interior wiring. Theft of current was found to be done usually by tampering with the wiring, removing pressure wires and jumping out meters, installing lamps ahead of the meter, and, in some instances, tampering with the meter so as to retard its rotation.

There was a brief discussion of this paper, when the meeting adjourned until Wednesday morning.

WEDNESDAY SESSION.

The first paper on the programme was that on "Economy in Minor Station Supplies," by Mr. Edgar B. Greene, of Altoona, Pa. The paper was discussed at length, after which Mr. Edgar made several announcements, and then called for the paper on "Notes on the Internal Combustion Engine as Applied to Central Station Service," by Mr. E. E. Arnold, of Pittsburg, Pa.

This paper took up the theory of the gas engine and the general types of apparatus as constructed to-day. The various forms of fuel gases and their analysis were taken up, and a table given of the performance of the Westinghouse gas engines under brake tests.

After the reading of this paper the president announced that there were three or four papers on kindred subjects, and that he would ask the gentlemen who are to take part in the discussion of these papers to wait until the papers have all been read and then have a general discussion of all of them at the same time. Pursuing that policy, he called for the paper on "Economy Test of a 5,500-Horse-Power Three-Cylinder Compound Engine and Generator," by Messrs. J. D. Andrews and W. F. Wells, New York.

The paper on "Mechanical Stokers" was passed for the time being, and the paper or report of the committee on investigation of steam turbines, Mr. W. C. L. Eglin, of Philadelphia, being the chairman of the committee, was heard.

The president announced that he had asked both the General Electric Company and the Westinghouse Electric and Manufacturing Company to either prepare papers on the subject of steam turbines, or to discuss them. Mr. Rice was prepared to discuss the subject, and Mr. Hodgkinson had prepared a paper on it.

Mr. Louis A. Ferguson moved that a vote of thanks be given Mr. Eglin and his associates for the excellent report which they had presented. Carried.

The paper on "Practical Notes on Steam Turbines," by Mr. Francis Hodgkinson, of Pittsburg, Pa., was read.

This paper took up, in turn, the theoretical principle of the steam turbine, its sources of loss, and various types of turbines; also the question of turbo-generators and the facility with which direct-connection may be had. The main data of the paper are concerned with the Westinghouse-Parsons turbine, manufactured by the Westinghouse Machine Company. A large table accompanied the paper, showing tests of the Westinghouse-Parsons steam turbine under various degrees of steam service.

Mr. Edgar called for the report of the committee on award of the Doherty Gold Medal, Dr. Schuyler S. Wheeler, of Ampere, N. J., being chairman.

Dr. Wheeler stated that the committee took the greatest pleasure in reading the several papers presented on the subject of "Underground Construction," and while there was another paper that commended itself in many ways, namely, one by Mr. Blood—Mr. Blood's paper was very good, exceedingly well put together, quite remarkable in that respect—yet there was another paper which, on account of its great mastery of detail and covering the whole subject so completely, the committee decided should have the preference. He would say that this conclusion was reached independently by each member of the committee. The members of the committee had no communication with each other until after they had finished their work, and the decision was unanimous and independent on the part of each member. The author of the paper selected was Mr. W. P. Hancock, of Boston. Mr. Hancock, who is now general operating superintendent of the Boston Edison company, was formally presented with the medal.

Mr. Edgar then called upon Mr. Doherty, who stated that he was prompted to offer this medal to stimulate a study

of underground methods. There seemed to be a lack of harmony in the methods in the various stations doing underground work. It seemed to him that unnecessary expense was incurred, and that the practice was not standardized; and he hoped to secure the contribution of a number of papers and that a standard practice could be formulated based on these papers. If the thing has been accomplished, he felt very well repaid for his efforts to secure the result.

The president announced that the four papers read during the morning—one by Mr. Andrews, on "An Economy Test of a 5,500-Horse-Power Three-Cylinder Compound Engine and Generator"; one by Mr. Arnold, on the "Gas Engine"; the report of the committee on the investigation of steam turbines, by Mr. Eglin, and the paper on "Practical Notes on Steam Turbines," by Mr. Francis Hodgkinson—were open for discussion, and Mr. Ralph D. Mershon was called upon.

Mr. Mershon said that the paper by Mr. Arnold interested him very much, but surprised him more, because from all the data he had been able to obtain in this country on the prices of gas engines and their auxiliary, he had not been able to get the results Mr. Arnold got on paper. He noticed in the plant on which Mr. Arnold has been figuring that nothing is allowed for relay capacity, and if that is done it will mean a greater investment and will be, of course, against the gas engine. He would ask him also whether or not the rated capacity of this plant is based on the ultimate capacity of the gas engine, or very nearly so, because if it is the comparison, it seemed to him manifestly unfair. He found that most of the gas-engine builders rate the gas engine at or near the load at which the engine will lie down, whereas with the steam engine we have at the expense of efficiency, in the case of an emergency, considerable overload capacity. It is very clear, he thought, that if, as will be the case with a good many loads, the load is subject to sudden fluctuations and swings, there must be enough capacity over the average load at which the engine is running to take care of these swings. In many cases the question of relay capacity and overload capacity will be taken care of by dividing up into a considerable number of small units. It is unfair, if this method is to be adopted to help the gas engine out, to compare such a gas-engine installation with a steam-engine installation divided up in the same way. So far as he could see from the paper, Mr. Arnold assumes that the efficiency of the gas engine and steam engine with different load-factors will be the same as the one figure he has taken—the relative efficiency will be the same. It seemed to him, from what he knows of gas-engine performances, that the gas engine should be figured as having less relative efficiency at the lighter loads. The relative costs that Mr. Arnold had taken per kilowatt for steam and gas installation are widely different from prices he has been able to get—Mr. Arnold gives the price per kilowatt for steam at $100 and for gas at $125. He thought this figure for the gas engine should not be under $150, and nearer $175, judging from figures he had received lately in quotations.

Mr. G. L. Tripp, Boston—I asked if gas engines being operated on twenty-four hours' continuous load, where there is considerable fluctuation, and where the engines and generators, direct-connected, are being separated in parallel, particularly a high-potential alternating-current installation.

Mr. Henry L. Doherty suggested calling upon Captain H. G. H. Tarr, of the R. D. Wood Company, to tell of the progress being made in the matter of fuel gas.

Mr. Tarr said, the greatest obstacle probably to gas-engine development has been that practically nothing was done in this country toward the development of the producer for power purposes up to the last two years. His firm had now perfected a producer so that they were running their own shops in connection with gas engines with excellent results in the use of bituminous coal.

Mr. Edgar called upon Mr. Richard H. Rice, of Lynn, Mass., representing the General Electric Company, to say a word on the turbine situation.

Mr. Rice said, the Curtis turbine consists, in its simplest form, of one or more stationary nozzles which discharge steam at high velocity into several rows of moving buckets alternately with stationary buckets, the office of which is to reverse the jets of steam and redirect them in a manner suitable for use in the next row of revolving buckets, until finally the steam is discharged from the last row of buckets and its velocity practically absorbed. By removing only a portion of the velocity from each row of buckets, and by providing a succession of rows, the velocity of the wheel is proportionately reduced. The Curtis turbine possessed another and most effective way of keeping down the speed of the buckets. If we confine ourselves, instead of expanding our steam from boiler pressure to vacuum in one operation, to an expansion of one-half or one-quarter of this amount, we considerably reduce the losses in the nozzle and also the velocity of the steam. In having a lower velocity, we can absorb this velocity with a considerably lower bucket velocity. It is then simply necessary to divide two or more sets of expanding nozzles in series, each with several rows of moving and stationary buckets, to entirely neutralize the energy of the steam. These groups are termed staged, and the Curtis turbine is at present built with one to three or four stages depending on size, the steam pressure, and whether we are expanding into the atmosphere or into a condenser. The flow of steam through a nozzle follows perfectly definite laws, and enough is known of these laws to enable us to predict the velocity developed by nozzles of various form with accuracy. Furthermore, the flow of steam at any given pressure through a nozzle of given size can be calculated as accurately as it can be condensed and measured.

We have, therefore, means of accurately determining the weight and velocity of the steam as it strikes the buckets. If the velocities of steam used in the Curtis turbines were utilized in the single row of buckets the speed of the bucket rows would have to be nearly one-half of the velocity of the steam in order to obtain the highest efficiency. However, by using several rows of buckets a portion of the velocity is utilized in each row, and instead of being obliged to run our wheels at a speed of 1,200 feet, or even 600 feet, as in the case of some types of turbines, we can use the steam at more conservative speeds of 250 feet per second as a minimum up to 450 feet as a maximum. This low bucket speed also brings along with it another very important advantage, combined as it is with the use of a very moderate number of nozzles to admit the steam to the first stage. He referred to the low speed of rotation which follows from low bucket speed and the possibility of large wheel diameters, since we are not, as in some types, obliged to admit steam around the entire circumference of our wheels.

The Curtis buckets are machined from the solid material of the bucket wheel, or from the metal of a substantial solid segment, securely fastened to the wheel rim, or cast from appropriate material in the same solid way, and the ends of the buckets are covered by metallic bands rivetted to the bucket ends. While the strains in the buckets are considerably less than in other types, because of the low bucket speed in the Curtis turbines, the construction is in every way more substantial. The bucket wheels are also free to expand in the direction of their diameters, and the buckets are free from possibility of injury by coming in contact with stationary parts.

These turbines are constructed in sizes varying from 1.25 to 5,000 kilowatts. Up to and including 300 kilowatts the turbines are constructed on the horizontal type. From and including 500 kilowatts upward, the shafts are vertical. The packings used between the steam and the atmosphere are sealed by steam, no oil coming in contact with the steam. Therefore, the condenser steam can be returned to the boiler and used over and over again without fear of deterioration of the boiler surfaces. The advantage of the vertical arrangement, where the weight of the rotating element is considerable, is almost self-evident. Friction and wear on the bearings are reduced to a minimum, and in our largest turbine it is possible to move the rotating parts by hand when the oil pressure is on the step bearing. This step bearing consists of a pair of cast-iron discs, one rotating with the shaft and attached to the bottom end thereof, the other stationary, placed vertically under the shaft and adjustable upward and downward, to adjust the position of the rotating elements. These discs are kept out of contact by means of a film of oil which is forced between them by a pump,

sufficient pressure being exerted to lift the shaft. The shaft, therefore, rotates on a film of oil of definite thickness. The oil pressure is maintained to a uniform amount by means of an accumulator.

Regulation of speed is performed by a shaft governor of great power and sensitiveness which actuates instantly through suitable apparatus a series of valves, each one of which admits or cuts off the supply of steam from one or more nozzles. These valves are always either fully opened or closed. No throttling occurs, and the nozzles therefore always work at their maximum efficiency. To this fact is due the high efficiency of the Curtis turbine at variable loads. Tests under actual working conditions have shown that with a variable load the turbine maintains its efficiency, due to the fact that the nozzles are always operating under their designed conditions.

Fortunately, it is easy to obtain a high vacuum with the turbine at a very moderate increase in the cost of the condensing apparatus as compared with that necessary to obtain twenty-six or twenty-seven inches; and although a high vacuum is not essential to the proper operation of the turbine, the turbine is capable of utilizing the energy contained in steam to a much greater extent, and therefore the economy of the turbine is increased by the increase in the vacuum. The turbine is free from air leaks and with a short connecting pipe between the condenser and turbine, and a condenser of liberal size, twenty-nine-inch vacuum, is being obtained in many cases. Objection has been made by some that an excessive quantity of cool water is necessary, but that is not the case; only 2.5 to three times the usual amount of water being used, and its quality is not important. Roughly speaking, it may be stated that the gain by increasing the vacuum varies with the amount of the vacuum becoming greater as the vacuum increases, but in general it may be stated that high vacua with one inch of vacuum is equal to five or six per cent gain in economy. Other forms of condensing apparatus than surface condensers are used to some extent in connection with turbines. When the water supply is limited cooling towers may be used, and when it is ample and it is not desired to return the condensed water to the boiler, syphon condensers with dry air pumps may be installed with good results.

Without going into the details in the matter of steam consumption, it may be stated that the turbine uses no more steam than the best reciprocating engines—both tested when new and under other similar test conditions. In practical work, with the load varying considerably, for instance, when the engine is driving a street railway, the efficiency of the reciprocating engine is considerably reduced. The turbine is not subject to this reduction of economy, but gives the same average economy with varying load under the most unfavorable conditions. Tests with a very variable load have shown that the average steam consumption at the average load is exactly the same as if the load had been stationary at this average amount for the same length of time. The steam engine deals with the pressure and application of the steam; consequently the valves and pistons must be steam-tight and always remain so. The steam turbine deals with the mass and velocity, and is therefore independent of tightness for its economy, and it has no packings similar to piston or valve packings. The advantage of this is that it retains its original economy as long as it is operated, while the steam engine rapidly loses efficiency due to the wear of these parts. While, therefore, there may be equally high efficiency at the beginning of service, ultimately the turbine will be in the lead. The only probable effect which is unfavorable is that of deterioration of the surfaces of the nozzles and buckets. The higher the steam velocity the greater this possibility becomes. We should, therefore, expect the wear on the Curtis turbine to be much less than in the De Laval, and less in the four-stage turbine than in a one or two-stage turbine. All of our large turbines are made with four stages at the present time. As a matter of fact, if such wear should take place it would be confined to parts not expensive and readily replaceable, and turbines operating for two or more years show no sign of it. We may reasonably expect that in the long run, and for service extending over a term of years, that the turbine will hold its economy better than the reciprocating engine.

As regards the advantage of the small floor space required by the turbine, a case has recently come to my notice where the conditions were unfavorable to the installation of turbines, yet in this case two engines of 500-kilowatt capacity were all that could be installed in a certain power station, whereas five turbines of the same size could be readily located.

The valves of the Curtis turbine are always under the control of the governor, even up to an overload of fifty per cent; therefore the economy load is continuous and does not change its characteristics. The cost of foundations is extremely small as compared with those of reciprocating engines, and in fact very little foundation is necessary. We have some turbines of 500-kilowatt capacity operating on the second floor of a mill and standing on floor beams.

Mr. W. L. Abbott, Chicago, asked Mr. Hodgkinson to describe the arrangement for the closed hot well, and what improvement in vacuum results from it? He also wanted to know what was the real advantage, and how much it amounts to, of superheated steam?

Mr. H. L. Doherty called attention to several points in connection with this discussion which he hoped would not be lost sight of. The characteristics of the steam turbine and the gas engine are very different. A gas engine is very efficient as far as heat used for useful work is concerned, but to get efficiency from the gas engine you will find generally that you get best results at the absolute maximum capacity of the gas engine, principally because you have certain constant losses which are there in the aggregate in the same quantity, regardless of the load on the engine, and these losses even amount to twenty-five per cent of the capacity of the engine. No matter what the load on the engine may be, the losses are twenty-five per cent of the capacity, and therefore if you have only half load on the engine the losses become fifty per cent. At Madison, Wis., his company has a gas-engine station, and it is now putting into the gas-engine station a steam turbine. The ability to operate steam turbines and gas engines together, and operate them economically, and perhaps more economically than either alone would permit, is a matter which he believed to be of considerable importance. The gas engine costs much more per horse-power at the start, and fixed charges are therefore heavier. Now, then, if a certain amount can be saved on the operating cost of a gas engine, one must be able to operate that gas engine a sufficient number of hours during the year to make that operating cost more than balance the increased fixed cost. With a low load-factor this can not be done, but if steam engines are already in, he thought the ideal arrangement for the use of a gas engine would be to put in an installation that would take care of a portion of the load, a portion only, and that portion which operates twenty-four hours a day. Instead of operating the engine to give you constant potential on the machine, if one will operate so that it runs at a uniform speed and its maximum load, and the fluctuations of the load are taken up with the present steam engines, there will be secured a high economy from the gas engine. The present steam engines, we know, are not efficient on a variable load, but a steam turbine has the characteristics of any rotary prime mover, and it has some peculiar characteristics of its own, chiefly the one that each part is working at the same temperature and gets away from the bad effects of fluctuations of temperature, and what would be the cylinder condensation of a steam engine; and therefore by using gas engines running at maximum load and arranging the governor so that the steam turbine will take up the fluctuation, a condition can be worked out where there will be a higher efficiency than with either one alone. In his own work he had not found that the lesser space required by the turbine could always be availed of without using a system of steam piping that would not readily appeal to good engineering practice, or what would be considered good engineering practice. There must be boilers which give a bigger capacity per lineal foot of the boiler room, and he is just now trying to interest one manufacturer in the building of a very deep boiler, but a very narrow boiler. The present boilers will stretch out a considerable distance in lineal feet, while the steam turbine could be put in a small space in the centre and in front of these boilers. There are two or three ways which have been proposed to overcome that difficulty—one was to have the boilers in stacks, back to back,

and have practically a double boiler room with a firedoor on each side and lead the steam piping from one firing alley to the engine room. Another plan is to build the boilers with the firing-doors at right angles to the turbine, and have short alleyways running up into this group of boilers. Another way was to design a special boiler having little width and considerable depth, and probably going to a vertical boiler. Another method that was suggested, but was not looked on with favor, was to put the boiler room on each side of the turbine room.

In replying to Mr. Mershon's remarks, Mr. Arnold said in regard to the relay capacity and rating of the engine that he took into consideration a lighting plant rated at 2,000 kilowatts capacity, with a twenty per cent load factor. A gas engine is ordinarily rated on its brake horse-power at about fifteen to twenty per cent under its maximum capacity, while the steam engines are rated on their indicated horse-power and have, say, fifty per cent overload on that. The difference between indicated and brake horse-power amounts to considerable, and the rated capacity of the two engines approach more closely than would ordinarily be supposed. The fact that this is a lighting station and had an ordinary twenty per cent load-factor, the relay capacity is well taken care of by the way the units are laid out. There may be any combination of gas-engine units or any combination of steam-engine units to fit the best load-curve, and the engine blocked in the manner which will best take care of it. In that manner it takes care of the relay capacity. You can run very small gas-engine units with approximately the same efficiency that you can run large gas-engine units, and the small gas-engine units are notably more efficient throughout their range of load than is the steam engine. Another point that comes right in there is the relative efficiency of the gas engine, which is spoken of as having a lower relative efficiency at light loads. He thought that while its efficiency does decrease as does the steam engine, it would be found that at half load the brake kinetic efficiency of the engine is twenty-one per cent, that is, heat input to the equivalent of the work done.

In regard to the relative skill required to operate the different engines and the amount of attendance necessary, Mr. Doherty had touched upon the fact that the large stations can be taken care of with much less attendance and also with less relative skill than is required in the boiler equipment of a small plant; and it has been their experience that the engineering skill, operating engineer, attendant upon the engine for the same size of engine and the same importance of the plant, is about equal. In reply to Mr. Tripp, as to plants operating in parallel, he would say that with perhaps one exception all the plants referred to in the paper have alternating-current generators operating in parallel, and there were other instances that might be cited. In regard to the twenty-four-hour service, a number of the plants referred to and illustrated were giving twenty-four hours' service.

Mr. Louis R. Alberger was called upon to answer Mr. Abbott's question with regard to the hot well. He said he supposed Mr. Abbott referred to the closed hot well in connection with dry vacuum systems, in which the water is collected in a closed hot well and pumped out into the atmosphere, and the air removed by a dry vacuum pump

Mr. Abbott asked if air is kept from coming in contact with condensation.

Mr. Alberger replied that there are various ways of accomplishing the separation—one is to keep all the air entirely away from the water, and one is to separate it after it comes in contact with the water.

Mr. Abbott said that what he had in mind was referring to Mr. Hodgkinson's remark on the advantages of a closed hot well. He had in mind another installation where the water is not kept absolutely from the air, and was wondering if there was a possible increase in efficiency by keeping it absolutely from contact with the air.

Mr. Alberger said that, if the water is kept away from the atmospheric air it is liable to keep its temperature better; and furthermore, you get the water free from air, and in that way avoid some of the troubles which have been found in connection with boiler plants using water from condensers which contained air and acted on the tubes by oxidation. The British admiralty has gone into that matter rather thoroughly in the last few years, and it finds if you keep the air from the water, and the water from the air, that this corrosion does not take place in the boilers. The ordinary wet-air pump which takes the water of condensation from the condenser and also the air in the condenser and then mixes them up together again, in the process of evaporation of the air, and puts the water into the hot well and the mixture is pumped into the boiler, some of the air escapes and then it is made into steam again, which is with the steam when the water is evaporated to be pumped off again. If the air is kept entirely separated from the water, and the water not allowed to come in contact with the atmospheric air, after it is once out of the condenser, it is liable to be kept out. It reduces the amount of work on the air pump and reduces the corrosion by oxidation.

GROUP OF DELEGATES AND VISITORS TO BOSTON, MASS., DURING THE TWENTY-SEVENTH CONVENTION OF THE NATIONAL ELECTRIC LIGHT ASSOCIATION, MAY 24–27, 1904.

The paper on "The Mechanical Stoker and Human Operator," by Mr. Edwin Yawger, Pittsburg, Pa., was read.

In opening the discussion Mr. C. H. Parker, Boston, said the main point seems to him to be the question of fire temperature. The higher the temperature of the fire the better the fire efficiency. It is shown clearly in all flue gas analyses that with low fire temperature and a low number of tons of coal burned per square foot of grate surface that you will have a large excess of free oxygen. When your fire is run up to forty or forty-five pounds per square foot of grate the excess is brought down to something like thirty to forty per cent above the theoretical requirements, and the fire is a dead white. In practice he found that the heating surface, however, of the boilers as ordinarily installed will not take up the heat as given off by this fire, and that the most economical point to work in is somewhere in the neighborhood of twenty-five per cent above the boiler rating. Where it is possible, with an even load condition, the maximum economy would come by reducing the grate area, working a greater number of pounds per square foot of heating surface, and working the heating surface at about twenty-five per cent above the rating.

Mr. R. S. Hale, Boston, stated that he had made and analyzed a great many boiler tests and it was his firm conviction that, other things being equal, the less draught that is used the higher will be the efficiency. If it is a question of geting a greater capacity, of course a greater draught must be supplied. If it is a question of burning more coal per square foot of surface and getting the same capacity as before, which of course means the cutting down of the grate surface, then of course more draught must be supplied; but other things being equal the less draught used the better will be the efficiency of evaporation. The point advanced by Mr. Yawger in regard to the saving made by increased draught, that the same volume of gas at the same temperature will give up more of its heat when passed rapidly than when passed slowly over the same heating area is a fallacy in so far as applies to this question. If the conditions, *i. e.*, the output of steam, are to remain the same, then the amount of coal and amount of gas must be reduced in order to gain any better efficiency and must pass more slowly over the heating surface. If increasing the draught must cause them to pass more rapidly it could have none other than a bad effect. The reason that the best efficiencies are gained with a small draught is that this makes it necessary to fire more carefully in order to keep up the capacity, and hence reduces the amount of air used, reducing the loss by the heat of the waste gases and also causing the gas to pass more slowly over the heating surface, giving the gases more time to give up their heat.

On motion, the meeting adjourned until ten o'clock on Thursday morning.

THURSDAY MORNING'S PROCEEDINGS.

President Edgar called the Thursday morning session to order at ten o'clock. The first paper was on "Electric Light and Power Plants in Connection with Ice Plants." This paper was read by the author, Mr. C. L. Wakefield, of Dallas, Tex. The paper was discussed quite fully, and points were brought out to show the value of the installation of private refrigerating plants operated by electricity. The discussion was led by George N. Tidd, N. T. Willcox, Arthur Williams, John T. Gilchrist, Leon H. Schenck and J. D. Andrews. This paper was followed by the report on "Sign and Decorative Lighting," by Arthur Williams, of New York. The report on "Advertising Methods," by La Rue Vredenburgh, followed. The discussion on these reports was protracted and interesting.

The committee on nominations was appointed as follows: P. G. Gossler, D. P. Robinson, Irvin Butterworth, W. C. L. Eglin and F. E. Smith.

The report of the committee on the president's address was presented by Mr. H. L. Doherty, chairman, and the committee approved the recommendations of the president.

The paper on "Purchased Electric Power in Factories" was read by Mr. W. H. Atkin, of Boston. This was discussed by Louis A. Ferguson, Arthur Williams, P. G. Gossler, Charles B. Burleigh and J. F. Dumesmay.

THURSDAY AFTERNOON SESSION.

The report of the committee on "District Heating" was the first business taken up in the afternoon session. This report was presented by Mr. E. F. McCabe, of Lewiston, Pa. The report on "Office Methods and Accounting" was presented by Frank W. Frueauff, of Denver. A paper on "A Proposed System of Standard Instruments for Operating Companies," by H. P. Davis, of Pittsburg, was read. This was followed by the paper on "Single-Phase Power Motors for Electric Lighting Stations," by W. A. Layman, of St. Louis.

REPORT OF COMMITTEE ON DISTRICT HEATING.

A list of twenty-four questions was prepared and sent out, with an explanatory circular letter outlining the objects of the committee and requesting replies in percentages, which, it was thought, would meet with the least objection from central station managers. Of 100 companies addressed, fifty-two made reply; thirty-six operating steam and sixteen hot-water systems. This report was entirely in tabular form.

REPORT ON OFFICE METHODS AND ACCOUNTING.

The author believes that to an incomplete system of records or to loose handling of a good system much of the trouble of management and many of the complaints of consumers and the public, as well as the failure to secure satisfactory earnings, may be traced. A company loses much in not securing the best efforts of its employés, through failure to know just what they are accomplishing. The lighting companies throughout the country are all making an effort to increase their sales of current, either to present users or to new consumers, or by taking on business that was formerly done by isolated plants or other forms of power. These conditions have necessitated a much closer study of costs and receipts, and have resulted in a much finer separation of the items entering into the cost of production for any particular class of current, or for consumers using service in an unusual way. The usual method of grouping all expenses under three arbitrary heads, of manufacture, distribution and general expenses, and making separation under them for different subdivisions desired, has only given average costs, and must therefore be misleading for purposes of figuring for new business to be secured, or for analyzing present results in order to know the profitable from the unprofitable business. The plan of apportioning the costs of operation to the class of the current made, and of separating fixed and variable costs, has come to be a necessary part of a company's report of operations. The companies are now realizing, as never before, that a satisfied consumer is one of the best assets. To make or hold these satisfied consumers requires careful and constant watching. A department of the business is established, where complaints are received and adjusted. They must be systematically followed up, or great dissatisfaction will result. A daily report is made from the order record, showing the number of complaints received, separated by classes, and showing the number of each class for the same day of the previous year, and the accumulative number received during the past month. A new departure is the establishment of a bureau of information. This bureau is located in the most conspicuous point in the office, and is in charge of a clerk thoroughly posted on all general matters of the company. One of the most important requirements for satisfactory relations with consumers is the necessity for accurate meter-reading and billing. Attention was called to the use of labor-saving devices, such as receipting machines, adding machines, self-adding sheets, slide rules, calculators and tube systems.

A PROPOSED SYSTEM OF STANDARD INSTRUMENTS FOR OPERATING COMPANIES.

Increased efficiency in the generation and utilization of electricity necessitates increased accuracy in the instruments designed to measure production and consumption. Mr. Davis thinks that the instruments now used as standards are inadequate for many kinds of work. Those that have the desired accuracy and reliability are complicated and require an unusual degree of skill in their use. Those that are more generally used and have the advantage of portability and ease in handling have secured their superiority in one direction by sacrificing important features in another. A source of error

in the instruments now generally used for standards, he states, is the effect produced upon them by external fields. This class of instruments is defective in having a small controlling force, requiring very light and delicately balanced moving parts, and making the instrument very sensitive to external forces, such as static attractions of the needle, jarring from shipment, and the tendency of the moving part not to return to full zero. The inaccuracies of hand-drawn scales and the difficulty of reading the fractional divisions are also sources of error, and at low readings the thickness of the pointer and of the hand-drawn devices amounts in some cases, he says, to as much as one per cent of the readings when at one-fifth of the normal capacity. The source from which relief from present inconveniences can most logically be expected is from the manufacturers of high-grade electrical instruments. It is not necessary that these standards take the place of ordinary portable instruments for the general run of service, in which a high degree of accuracy is not required, but they should be provided for the calibration of other instruments, especially those requiring long ranges, such as integrating wattmeters, and practically to furnish, in commercial form, copies of the legal reference standards.

At the executive session in the evening, certain changes in the by-laws were adopted, admitting individuals as well as companies to active and associate membership. The treasurer's report showed receipts of $19,865,97, and expenses of $10,397.17.

The following reports were then presented: report of committee on "Standard Rules for Electrical Construction and Operation," Captain William Brophy, Boston, Mass., chairman; report of committee on "Finance," Mr. H. H. Fairbanks, of Worcester, Mass., chairman; report of committee on "Relations with Kindred Organizations," Mr. James I. Ayer, Cambridge, Mass., chairman; report of committee on "Relations between Manufacturers and Central Station Companies," Mr. Henry L. Doherty, Denver, Col., chairman.

Invitations were received from Detroit, Philadelphia, New York and Niagara Falls for the next meeting of the association. The place of meeting, however, will be decided by the executive committee at some later date.

The report of the committee on nomination was unaminously received as follows: President E. H. Davis, Williamsport, Pa.; first vice-president, W. H. Blood, Jr., Seattle, Wash.; second vice-president, Arthur Williams, New York; Dudley Ferrand, Newark, N. J. New members of the executive committee were A. J. De Camp, Philadelphia, Pa.; S. Scovill, Cleveland, Ohio, and W. F. White.

A great many more remained for the social programme planned for Friday than was anticipated, but the attractions of Boston and the unusually elaborate and generous entertainment provided by the entertainment committee had proven so pleasant that great numbers changed their plans and instead of leaving Thursday night, immediately after the serious side of the convention was over, remained for the pleasures of Friday.

During the entire day Friday personally conducted trips were in order and visits were made to the historical spots around Boston—the Charleston Navy Yard, through the beautiful suburbs of the Newtons and Brookline, and in fact one party enjoyed the beautiful open scenery at Swampscott and historical Cape Ann. Surely, this Boston meeting will go on the records of the National Electric Light Association as being far and away the most enjoyable and satisfactory of any previous gathering. For this, primarily, full appreciation is due Mr. Charles L. Edgar, the retiring president of the association, as well as the entertainment committee, of which Mr. James I. Ayer was chairman.

Convention Notes.

BOSTON spread a canopy of blue sky and put on her best Sunday-go-to-meeting bib-and-tucker as a welcome to those of the electric lighting industry of America, and the men who manufacture the multitudinous forms of equipments and machinery used in the art of electric illumination.

Indeed, it was remarked by very many who had attended these annual gatherings, which, by the way, are the most popular meetings in the electrical fields, that at no previous meeting had there been evinced such a general sentiment of fraternal associations as during these days at Boston. The fact that the retiring president of the National Electric Light Association, Mr. Charles L. Edgar, and the entertainment committee decided to give the guests a typical New England welcome and entertainment, probably explains the feelings of good will and satisfaction expressed by those present.

The New England Telephone and Telegraph Company provided complimentary service with ample attendance for the guests, and both local and long-distance lines were free to them. About one thousand persons were registered on the books of the association, and it is estimated that a great many more were present during the sessions who were not included in this number.

It was noticed, too, that a larger percentage was present of the men from the operating system than heretofore, although the manufacturing side of the industry was especially well represented, with the exception of a few notable absentees.

Boston is well able to care for conventions of this sort, as it is blessed with numerous commodious, attractive and well-run hotels. While the sessions and association headquarters were at the Vendome, many of the visitors preferred the quiet of the Hotel Somerset, Touraine and other houses within walking distance.

Not many of the manufacturing companies made general exhibitions of apparatus and equipments this year, preferring to make the meeting a season of friendly intercourse. However, some of the local supply houses exhibited complete lines of lighting paraphernalia and many of the companies had engaged private drawing rooms for the reception of visitors.

It was suggested that the location of this convention would prevent many of the men who regularly attend these meetings from the West and South from being present, but quite to the contrary, it was a noteworthy fact that no previous convention of the association had brought together so many men and from widely different parts of the country; a pleasant feature of the event was the attendance of an unusually large number of ladies. To those who came for the social features the programme prepared was entirely adequate. On Wednesday afternoon a large coaching party enjoyed the beautiful suburban drives and the hospitality of several of the exclusive clubs. On Wednesday a steamer excursion took all those who cared to see the harbor and waterways of Boston; and on Wednesday evening practically the entire house was reserved for the visitors at the "Pop" concert. This latter entertainment was especially enjoyed.

The following is a list of the manufacturing companies and their representatives present, and others especially identified with the commercial side of electric lighting who were in attendance:

Bryan-Marsh Company—Guy V. Williams, manager New York office; George C. Keech, manager Chicago office; J. P. Williams, New York; D. W. Eyman, Philadelphia; W. C. Ballda, Boston; E. H. Houghton, manager Cincinnati office.

Stanley Instrument Company, Great Barrington, Mass.—W. E. Andrews, S. O. Ochs, F. J. Alderso, F. W. Sanford, E. W. Gough.

H. B. Camp Company, New York—Stephen A. Douglas, C. C. Baird.

The Standard Paint Company, New York—J. N. Richards, manager sales department, New York; L. G. Goodrich, Boston office.

Crouse-Hinds Electric Company, New York, Syracuse and Chicago—H. B. Crouse, F. M. Hawkins, S. S. Goody, Cornell Blanding, A. F. Hills; S. S. Grady, Boston; A. F. Hills, Syracuse.

Fort Wayne Electric Works, Fort Wayne,

Ind.—F. S. Hunting, general manager; A. A. Serva, Fort Wayne; T. L. Sturgeon, Philadelphia, manager; A. C. Lott, New York, manager; J. Allan Smith, Boston; James Kent, Fort Wayne; J. Helgerman, Fort Wayne.

National Carbon Company, Cleveland—N. C. Cotabish, sales manager; G. C. Crider, F. H. Murray, J. F. Kevlin, F. C. Park, A. E. Carrier, A. D. Spear, J. C. Irvine.

Manhattan Electric Supply Company, New York—J. W. McDowell.

Wheeler Reflector Company, Boston, Mass.—H. C. Hawkes, general manager.

Bullock Electric Manufacturing Company—John Jeffrey, assistant general manager sales department; Arthur Warren, manager publication department; E. W. Goldschmidt, G. H. Berg, E. T. Pardee, W. W. Ober.

Stanley Electric Manufacturing Company—Dr. F. A. C. Perrine, president; A. A. Morton, Ray D. Lillibridge, E. P. Barnes, R. Stahl, C. Safford, W. W. Henshaw.

American Diesel Engine Company, New York—Norman McCarthy, general sales manager; J. D. McPherson, assistant chief engineer.

Diehl Manufacturing Company, Elizabethport, N. J.—B. C. Kenyon, president.

Standard Vitrified Conduit Company, New York—Bleeker S. Barnard, president.

National Electric Company, Milwaukee—M. E. Baird, manager Philadelphia office; J. D. McGuire, representing New York office.

Osburn Flexible Conduit Company—C. E. Corregan, vice-president; H. G. Osborn, I. A. Bennett, Chicago; Calvin B. Roulet.

Benjamin Electric Manufacturing Company, Chicago and New York—Basil G. Kodjbanoff, manager eastern and export departments.

Pass & Seymour, Inc., Solvay, N. Y.—B. E. Salisbury, secretary and general manager; John W. Brooks, sales manager; W. Brewster Hall, New York sales agent; A. M. Little, Boston sales agent.

Hunter Fan and Motor Company, Fulton, N. Y.—Represented by E. B. Latham, manager the New York and export department.

The J. M. Carpenter Tap and Die Company, Pawtucket, R. I.—J. E. Osgood.

John A. Roebling's Sons Company, Trenton and New York—H. L. Shippy, treasurer; M. R. Cockey, F. W. Harrington, C. B. Cushing, Albert Mann, G. W. Swan, D. G. Tingley.

The Phelps Company, Detroit, Mich.—W. E. Phelps and F. L. DuBroy, sales manager.

American Vitrified Conduit Company, New York—Stephen A. Douglas.

Atlantic Insulated Wire and Cable Company, New York—George F. Porter, sales manager.

J. G. White & Company, New York—P. G. Gossler.

W. S. Barstow, New York, consulting engineer.

Simplex Electric Heating Company, Cambridgeport, Mass.—James I. Ayer, manager; A. W. Doe, Charles W. Richards, Roger Williams.

Professor W. E. Goldsborough and Professor Charles E. Matthews, Purdue University, La Fayette, Ind.

Frederic Sargent, Chicago, consulting engineer.

Crocker-Wheeler Company, Ampere, N. J.—Dr. S. S. Wheeler, president; R. N. C. Barnes, Boston office; Charles R. Metcalf, of Boston; A. L. Doremus.

Shelby Electric Company, Shelby, Ohio—C. W. Cartwright, manager Boston office.

American Circular Loom Company, Chelsea, Mass.—A. T. Clark, president; T. H. Bibber.

General Incandescent Arc Light Company—A. Foster, Boston manager; Francis Raymond, Chicago manager; Robert S. Hale, Boston; P. H. Klein, Jr.

Pittsburg Reduction Company—Percy Hodges, manager Boston office.

Holtzer-Cabot Electric Company, Brookline, Mass.—C. W. Holtzer, president.

Lundin Electric Manufacturing Company, Boston—Emil O. Lundin, president.

Marshall-Sanders Company, Boston—Norman Marshall, C. A. Sanders.

Simplex Electric Company, Boston—Everett Morss, J. H. Mason, C. L. Morgan, W. S. Davis, S. D. Gloss.

H. S. Potter Electric Company, Boston—H. S. Potter, president.

Pettingell-Andrews Company, Boston—Charles B. Price, treasurer and manager; R. W. Vose, D. G. Brokaw, E. O. Johnson, H. H. Van Staugen, G. E. Palmer, F. W. Cramphorn, W. A. Peterson, Frank S. Price, G. H. Buckminster.

S. B. Condit Company, Boston—S. B. Condit, Jr.

Frank Ridlon Company, Boston—Frank Ridlon, E. W. Kellogg.

National Conduit and Cable Company—F. E. Smith, manager Boston office; J. A. McQuade, Jr., J. B. Honan, W. S. Eckert.

Professor H. B. Smith, of Worcester Polytechnic Institute, was present.

The Electric Storage Battery Company, Philadelphia—Charles Blizard, general manager, Philadelphia; F. J. Stove, Philadelphia.

Stuart-Howland Company, Boston—G. M. Stuart, treasurer and general manager; A. E. Payne, H. De Steese, C. R. Fish, V. C. B. Wetmore, R. M. Merrill, T. W. Mosher, Arthur Howland.

The Lord Electric Company, Boston—F. W. Lord.

The New York & Ohio Company, Warren, Ohio—W. D. Packard, R. B. Edes.

Hale & Codman, Boston—R. A. Hale.

Weatherbee & Whitney, Boston—S. B. Weatherbee.

Baker & Company, Inc., Newark, N. J.—J. J. Lowthian.

Electric Carriage Call Company, New York—Mortimer Worden, T. G. Bloomberg.

W. S. Hill Electric Company, New Bedford, Mass.—C. S. Meudell, C. H. Kean, F. E. Waterman.

Massachusetts Chemical Company, Boston—C. E. Green, president; C. E. Farrington, chief engineer; L. O. Duclos, sales manager.

McKenny & Waterbury—U. I. Allen, Jr., Robert J. Green, C. H. Klein, A. E. Phelps, F. F. Martin.

Duncan Electric Manufacturing Company, La Fayette, Ind.—Thomas Duncan, president; William H. Sinks.

Phœnix Glass Company, New York and Pittsburg—A. H. Patterson, E. H. Peck.

C. S. Knowles Company, electrical supply house—Joseph Keefe, Charles S. Clark, D. Kennedy, George Ober, G. S. Hutchins, H. M. Saben.

H. W. Johns-Manville Company—James Humphreys, Joseph Sachs, H. Trainer.

Weston Electrical Instrument Company, Waverly Park, N. J.—George H. Moseman, E. L. Cameron, Boston.

Holophane Glass Company, New York—J. S. Codman, representing the Boston agents, Hale & Codman.

Speer Carbon Company, St. Marys, Pa.—J. S. Speer, general manager; Andrew Kane, treasurer; George Cutter, manager, Chicago.

Field-Foulks, New York—C. J. Field.

Buckeye Electric Company, Cleveland—LeRoy Sawyer, manager.

Federal Electric Company, Chicago—W. H. McClain.

H. T. Paiste Company, Philadelphia—E. A. Jenkins, secretary.

Sanderson & Porter, engineers, New York—W. A. Haller.

The Minerallac Company, Chicago—W. E. Weisenheimer, manager.

Chicago Fuse Wire Manufacturing Company—Richard W. Smith, Boston manager.

Swazey & Smith, Boston—Thomas Dun, H. W. Smith.

The Okonite Company, Limited, New York—Willard L. Candee, George T. Manson, and staff of Pettingell-Andrews Company.

The Dale Company, New York—Jonathan Dale, president.

India-Rubber and Gutta-Percha Company, New York—J. B. Olson, sales manager. Dr. W. M. Habirshaw, who has been ill for some time, was also present.

Warren Electric Manufacturing Company, Sandusky, Ohio—C. H. Cotton.

J. H. Hallberg, consulting expert, New York.

Sprague Electric Company, New York—Alex. Henderson, H. G. Issertel, J. M. Ketcham.

Bryant Electric Company, Bridgeport, Ct.—F. V. Burton.

Chase-Shawmut Company, Newburyport, Mass.—H. P. Moore, sales manager; F. D. Masterson, J. J. Milsey, S. B. Crafts.

Peerless Electric Company, Warren, Ohio—Arthur Dunlap.

De Laval Steam Turbine Company, New York—Charles Garrison.

Safety Insulated Wire and Cable Company, New York—F. B. Parsons, manager Boston office.

American Electric Works, Phillipsdale, R. I.—Frank B. Baker.

American District Steam Company, Lockport, N. Y.—Charles R. Bishop, H. C. Eddy, Chicago.

Munder Electric Works, Springfield, Mass.—Charles F. Munder, president; C. J. Purdie, New York.

Gould Storage Battery Company, New York and Chicago—E. L. Draffen, manager Chicago office.

Crescent Gas and Fixture Company, Bridgeton, N. J.—H. S. Beaman.

Trenton Porcelain Works, Trenton, N. J.—George E. McGuire, Russell Howland.

Harvey Hubbell, manufacturer, Bridgeport, Ct.—T. S. McLean.

D'Olier Engineering Company, Philadelphia—L. B. Pollard, New York.

Triumph Electric Company, Cincinnati—Charles A. Cotton, manager Boston branch.

T. R. Mercein, of the Northwestern Electric Light Association, was present.

Western Electric Company—E. W. Rockafellow, E. N. Barton, A. C. Morse.

Clark & Mills Electric Company, Boston—W. E. Clark.

Dearborn Drug and Chemical Company, Chicago and New York—W. H. Edgar, Chicago; W. B. McVicker, New York.

New York Insulated Wire Company, New York—James Wolff, manager Chicago office; Frank Booth, W. B. Fearing.

Crouse-Tremaine Carbon Company, Fostoria—J. B. Crouse.

Bates Advertising Company, New York—Converse D. Marsh.

Kinney Electric Company, Boston—C. A. Brown.

The Jandus Electric Company, Cleveland—Edward L. Nash, manager New York office; J. H. Cramphorn.

Kinsman Electric Railway Supply Company, New York—F. E. Kinsman.

Ballou-Hutchins Electric Company, Providence, R. I.—C. A. Ballou.

J. M. Knot, who has been active in electrical matters for many years, was present.

The Phillips Insulated Wire Company, Pawtucket, R. I.—A. N. Palmer.

D. & W. Fuse Company, Providence—W. S. Sisson.

R. D. Wood & Company, Philadelphia—C. W. Lummis, H. G. H. Carr.

Wagner Electric Manufacturing Company, St. Louis, Mo.—B. Faxon, John Mustard, Philadelphia office; E. W. Goldschmidt, G. I. Barkhouse, New York; W. A. Layman.

Doubleday-Hill Electric Company, Pittsburg—Charles Phillips Hill, sales manager.

Faraday Carbon Company, Jeannette—A. E. Carrier.

Re-New Lamp Company, Boston—H. Hastings, treasurer; George H. Smith.

W. F. Weiss, the New York accountant, was present.

Bossert Electric Manufacturing Company, Utica, N. Y.—Frank G. Schofield.

Tipless Lamp Company, New York—R. S. Carrick.

Hart & Hegeman Manufacturing Company, Hartford—Alfred F. Pease, president; T. C. Sias.

Crescent Insulated Wire Company, Trenton—Louis F. Jackson.

Alberger Condenser Company, New York—L. R. Alberger, president; H. M. Montgomery.

Maguet Wire Company, New York—Hamilton Hill, Boston manager.

The Wire and Cable Company, Montreal—B. F. Lise.

Dossert & Company, New York—J. J. Dossert, president; A. H. Willmont, secretary.

Fostoria Incandescent Lamp Company, Fostoria, Ohio—H. S. Potter, B. G. Tremaine.

Marion Insulated Wire Company, Marion, Ind.—J. L. Lucas.

Hart Manufacturing Company—President Hart, F. B. Smith, Boston manager.

Alphaduct Manufacturing Company, New York—Russell Dart, president.

Standard Varnish Works, New York—John C. Dolph.

Adams-Bagnall Electric Company, Cleveland—T. A. Thomson, New York manager; Charles Phillips Hill, Pittsburg.

McIntosh, Seymour & Co.—A. E. Merrill, manager New York office.

Warner Arc Lamp Company—Jonathan A. Stewart, Cincinnati.

J. P. Frink, manufacturer, New York—Frank Stout.

Electric Material Company, Baltimore—A. L. Bosley.

Lombard Governor Company, Boston—Allan V. Garratt, R. B. Scrafford.

W. H. A. Davidson, manager of sales, Richmond Electric Company, Richmond, Va.

C. F. Splitdorf, manufacturer, New York—A. Kowastch.

The Allis-Chalmers-Bullock interests were represented by Arthur Warren, manager of the department of publicity; G. H. Berg, manager of the Boston office of the Bullock company; H. E. Rundlett, manager of the Boston office of the Allis-Chalmers companies; J. R. Jeffrey, assistant secretary of the Bullock Electric Manufacturing Company; E. W. Goldschmidt, manager of the Bullock offices in New York; E. T. Pardee and W. N. Ober, both of the Bullock company's Boston office.

The Westinghouse exhibit displayed in the parlors on the ground floor of the Hotel Vendome was of especial interest because of the number of new appliances shown for use in electric lighting and central station practice. Much attention was given by visitors to the Westinghouse type "A" integrating wattmeter, which presents several essential improvements over the well-known integrating wattmeters of that company. Single and polyphase instruments in metal cases, single-phase with glass case, and master wattmeters of this type in glass cases for central station use in checking service meters, were shown. Models of the mechanism on a magnified scale were used to show the construction of those portions of the instrument which form its distinguishing characteristics.

A new type of high-grade portable testing instrument excited very favorable comments on account of its superior finish and attractive appearance. Of this type were shown a voltmeter, an ammeter, a single-phase and a polyphase wattmeter and a power-factor meter.

The line of arc lamps included five different types or styles: series alternating, multiple alternating, series multiple alternating, and direct-current series and multiple lamps; all of the enclosed type and new designs of high efficiency.

The fan motors were represented in the exhibit by several groups of these devices, some of which were effectively utilized to keep the room cool.

A type "B" oil circuit-breaker for switchboard use received considerable attention because of its compact form, simplicity, strength of construction and high degree of insulation.

A new departure in standardizing methods was foreshadowed by the display of a new series of precision instruments, having the advantages of the ordinary instrument—portability and convenience—combined with the unusual accuracy and permanency of the Kelvin balance.

The Sawyer-Man Electric Company, of New York, made its first public display of the Lumino lamp. The lamps were used to light a large candlelabra in the main Westinghouse exhibit room and attracted very favorable attention because of their brilliancy. The lamp is of fifty-four candlepower and shows a remarkably low wattage. A handsomely engraved card, showing the Lumino lamp, full size, was distributed to all visitors. A full line of standard incandescent lamps was likewise shown by this company.

The Westinghouse exhibit was in charge of Mr. R. L. Warner, New England manager of the Westinghouse Electric and Manufacturing Company, who was ably assisted by the Boston men. A great number of the officials of the company were in attendance, as follows: F. H. Taylor, vice-president Westinghouse Electric and Manufacturing Company, Pittsburg; Arthur Hartwell, sales manager, Westinghouse Electric and Manufacturing Company, Pittsburg; W. H. Whiteside, manager detail and supply department, Pittsburg; R. L. Warner, New England manager Westinghouse Electric and Manufacturing Company, Boston; C. B. Humphrey, manager Westinghouse Electric and Manufacturing Company, Cincinnati, Ohio; W. F. Fowler, manager Westinghouse Electric and Manufacturing Company, Baltimore, Md.; H. D. Bayne, manager Montreal office Canadian Westinghouse Company, Montreal, Canada; C. W. Underwood, manager Westinghouse Electric and Manufacturing Company, Buffalo, N. Y.; G. B. Dusinberre, manager Westinghouse Electric and Manufacturing Company, Cleveland, Ohio; D. E. Manson, manager Westinghouse Electric and Manufacturing Company, Boston; Andrew Raeburn, manager Westinghouse Machine Company, Boston; C. C. Chappelle, manager Westinghouse Machine Company, Chicago, Ill.; L. L. Brinsmade, manager Westinghouse Machine Company, New York; H. P. Davis, assistant chief engineer, detail department, Westinghouse Electric and Manufacturing Company, Pittsburg; F. F. Rohrer, manager direct-current department, Westinghouse Electric and Manufacturing Company, Pittsburg; C. W. Register, Westinghouse Electric and Manufacturing Company, Chicago, Ill.; J. B. Comstock, Westinghouse Electric and Manufacturing Company, Pittsburg; Henry Watts, Westinghouse Electric and Manufacturing Company, Buffalo, N. Y.; A. Goodby, Westinghouse Electric and Manufacturing Company, Pittsburg; George W. Pulver, Westinghouse Electric and Manufacturing Company, Syracuse, N. Y.; Frank B. Erwin, Westinghouse Electric and Manufacturing Company, Syracuse, N. Y.; O. T. Smith, Westinghouse Electric and Manufacturing Company, New York; C. E. Skinner, Westinghouse Electric and Manufacturing Company, Pittsburg; E. E. Arnold, Westinghouse Machine Company, Pittsburg; F. E. Conrad, Westinghouse Electric and Manufacturing Company, Pittsburg; Francis Hodgkinson, Westinghouse Machine Company, Pittsburg; J. H. Smith, Westinghouse Electric and Manufacturing Company, Pittsburg; Edwin Yawger, Westinghouse Machine Company, Pittsburg; H. R. Stuart, Westinghouse Electric and Manufacturing Company, Pittsburg; R. L. Rathbone, Westinghouse Electric and Manufacturing Company, Detroit; C. S. Jennings, Sawyer-Man Electric Company, New York; C. G. Wilson, Westinghouse, Church, Kerr & Company, Boston; S. M. Bramman, Westinghouse Machine Company, Boston; F. F. Breed, Westinghouse Machine Company, Boston; J. W. Lucas, Westinghouse Electric and Manufacturing Company, Philadelphia; C. L. Abbott, E. D. Mills, M. H. Merill, G. M. Bates, R. S. Brown, F. S. Perry, G. L. Osborne, G. S. Gibbs, T. W. Varley, C. P. Wahn, M. N. Davis, W. H. Baldwin, T. B. Sweeny, Westinghouse Electric and Manufacturing Company, Boston.

The General Electric Company, Schenectady, N. Y.—J. R. Lovejoy, general manager railway lighting and supply department, Schenectady, N. Y.; C. B. Davis, manager Boston office, Boston, Mass.; E. D. Mullen, manager Philadelphia office, Philadelphia, Pa.; A. F. Giles, manager Atlanta office, Atlanta, Ga.; J. B. Pevear, manager Cincinnati office, Cincinnati, Ohio; E. H. Mullin, A. D. Babson, New York; C. D. Haskins, H. W. Hillman, E. E. Gilbert, P. D. Wagoner, D. R. Bullen, F. G. Vaughen, Schenectady, N. Y.; W. C. Fish, manager Lynn works, Lynn, Mass.; R. Fleming, Lynn, Mass.; F. M. Laxton, Atlanta, Ga.; J. C. Kalish, Buffalo, N. Y.; W. J. Hanley, Cincinnati, Ohio; J. Scribner, Chicago, Ill.; W. T. Wooley, Denver, Col.; H. L. Monroe, Dallas, Tex.; A. D. Page, manager lamp and sales department, Harrison, N. J.; George F. Morrison, manager lamp works, Harrison, N. J.; H. J. Buddy, Philadelphia, Pa.; T. E. Bibbins, San Francisco, Cal.; H. H. Crowell, Syracuse, N. Y.; F. W. Wilcox, Harrison, N. J.; J. P. Felton, Boston, Mass.; F. M. Kimball, Boston, Mass.; S. B. Paine, Boston, Mass.

Albert & J. M. Anderson Manufacturing Company, Boston—J. M. Anderson, Ernest Woltman, manager New York office.

James G. Biddle, manufacturers' agent, Philadelphia.

Buckeye Engine Company, Cleveland, Ohio—A. K. Asworth, manager Boston office.

E. B. Latham & Company, New York—E. B. Latham, president.

National Wire Corporation, New Haven—Frank B. Parsons, manager Boston office.

Eastern Electric Company, Boston—E. W. Cushing.

New Britain Machine Company, New Britain—Robert S. Brown.

Standard Electrical Manufacturing Company, Niles, Ohio—J. P. Gilbert, manager.

Independent Incandescent Lamp Company, Cleveland—W. M. Rothchild, treasurer.

Wirt Electric Company, Philadelphia—W. J. Thompson.

Lynn Incandescent Lamp Company, Boston—Webster Bruce.

Gould Storage Battery Company, New York—W. E. Windship.

Sunbeam Incandescent Lamp Company, Chicago—F. S. Terry, president.

Harvey Hubbell, Bridgeport—Russell Howland.

Hart Manufacturing Company—G. W. Hart, president.

India Rubber and Gutta Percha Insulating Company—Dr. W. M. Habirshaw.

F. A. Snow, Boston—Franklin A. Snow.

Green Fuel Economizer Company, Matteawan, N. Y.—H. G. Brinkerhoff and G. H. Gleason, Boston office.

Blood & Hale, engineers, Boston—J. B. Blood.

American Steel and Wire Company—J. D. Sutherland, Worcester; Vincent Goldwaithe, Boston; A. F. Walker, Boston; F. A. Keys, manager of Boston office; R. K. Sheppard, Philadelphia.

Alphons Custodis Chimney Company, New York—H. C. Thompson.

Chapman Valve Manufacturing Company, Indian Orchard, Mass.—E. G. Howard.

Robertson Electric Company, Buffalo, N. Y.—W. E. Robertson, president.

Colonial Electric Company, Ravenna, Ohio—W. F. Curtis.

National Pipe Bending Company, New Haven, Ct.—W. G. Ruggles.

American Electrical Works, Phillipsdale, R. I.—W. J. Watson, manager N. Y. office.

H. J. Gorke, supply dealer, Syracuse, N. Y.

Ansonia Brass and Copper Company, New York—F. H. Sherwood, manager Boston office.

Ray D. Lillibridge, New York, head of the advertising and publishing organization of that name.

Heine Safety Boiler Company, St. Louis—E. L. McGregory, manager Boston office.

D. H. Darrin & Company, New York—E. H. Darrin, president.

PREDETERMINATION OF SPARKING IN DIRECT-CURRENT MACHINES.[1]

BY W. L. WATERS.

Speaking generally, dynamo design did not become an art until after the old two-pole smooth core Siemens and Edison machines came into extensive use for lighting. The original design of these machines was more or less guesswork; but after a few machines had been made to run satisfactorily the designer was able to lay out a complete line of machines, designing them partly by eye and partly by some empirical rules, which he decided on as he built successive machines. The armatures were designed more from a mechanical than from an electrical standpoint, the length being limited by the stiffness of the shaft rather than by question of commutation. The armatures were not ventilated and the output was necessarily limited by heating. The armatures being of the smooth-core type, the self-induction of the armature coils was so small, even with the length of armatures in general use, that usually it was not necessary to consider it in connection with the sparking of the machine. It was, however, generally recognized that if the magnets were too weak the machine was likely to spark, so the length of the air-gap was usually determined by some empirical rule obtained by experiment. When slotted armatures were adopted extensively they were designed along the same lines as smooth-core armatures. These armatures were so badly ventilated that the output was limited by heating to about one-half that of a modern armature; but in spite of this it was found necessary to use carbon brushes to obtain good commutation.

To economize in dies several different lengths of armatures were frequently built on the same diameter, and to economize space the armatures were often built smaller in diameter and longer than they otherwise would be. Experience with these different forms of armature made it very evident that a long armature had a greater tendency to spark than a short one; this became especially noticeable as the ventilating of armatures was improved and the output increased, so as to take advantage of the cooler running.

Up to this time a great deal had been written on the theory of commutation in dynamos, but had been ignored by the practical designer who had more faith in experimental results. This bad behavior of long armatures as regards sparking called attention to the theoretical work, and designers began to consider whether or not the self-induction of the commutated coil did not, after all, decide the amount of current the machine would carry without sparking. In the first attempts to take into account the self-induction of the commutated coil, the self-induction of a one-turn coil was considered as being simply proportional to the length of the armature core; that is, the shape and size of the slot, the number of coils per slot, and the self-induction of the end connections—all were neglected. This gave a very simple formula for the self-induction:

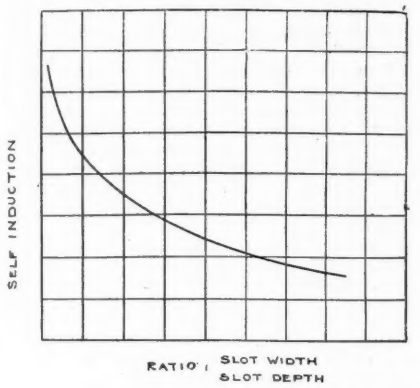


FIG. 1.—SELF-INDUCTION CURVE.

$$L = l\,n^2.$$

Where l = length of armature

n = number of turns per coil.

And the self-induction electromotive force of commutation (the reactance voltage as it was called), which is an estimate of the difficulty of commutating the current, was given by

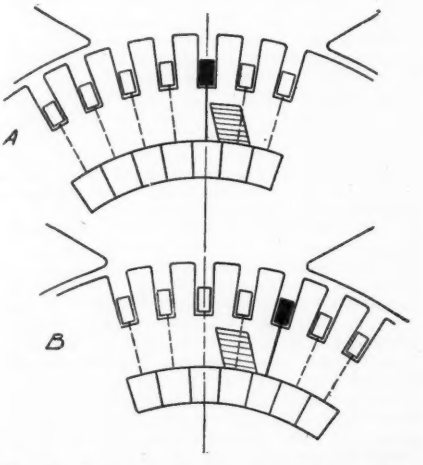


FIG. 2.—SHOWING POSITION OF ARMATURE AT BEGINNING AND ENDING OF COMMUTATOR PERIOD.

$$E = l\,n^2\,I\,f$$

I being the current per coil and f the frequency of commutation.

This formula gave good results when applied to machines designed along the same general lines. The allowable value of the reactance voltage could be obtained from experiments on one machine and used in the design of other machines. But, if applied to machines which were designed differently, the formula showed wide discrepancies; so it soon became recognized that the formula was at best only a rough approximation.

Early slotted machines were designed with one coil per slot; two coils per slot obviously saved insulation space and was soon tried, but it was found that generally every other bar on the commutator became badly marked.

As it was imperative to save space in car motors, three coils per slot were adopted, and in extreme cases four or even five coils per slot were used. It was generally found, however, that whenever more than one coil per slot was used some of the commutator bars were marked, and that it was possible to count the number of coils per slot by the recurrence of the marking on the commutator. This marking was attributed to the inequality caused by using a small number of slots, and so the general rules were adopted—to use as many slots as possible and to make small machines with one coil per slot and large machines with two coils per slot.

It was also noticed that the dead coils necessary in certain mutipolar wave-windings often caused some of the commutator bars to be marked; this was naturally attributed to the dissymmetry produced in the winding, and it became generally recognized that anything tending to produce inequality in the commutation conditions, such as few slots or many coils per slot, or dead coils, tended to make perfect commutation more difficult.

With increased competition came the necessity of cheapening the cost of building these machines; designers then returned to the construction of several coils per slot. In reducing the amount of copper on the armatures to save in the cost of material, it naturally happened that shallow slots were used. And it was found that with these wide and shallow slots it was possible to obtain good commutation with several coils per slot, under conditions where it would be quite impossible with the old deep and narrow slots. Obviously this was due to the lesser self-induction of a wide slot compared to a narrow one, and it was soon acknowledged that the shape of the slot should be considered in calculating the self-induction of the commutated coil.

When designing an armature for

[1] A paper presented at the 187th meeting of the American Institute of Electrical Engineers, New York, May 17-18, 1904.

small self-induction it would be natural to make it large in diameter and short in length; that is, with a large pole-pitch. But in carrying this to an extreme it was found that it did not give the good results expected. It was suggested that this result was due to the fact that the self-induction of the end connections had been neglected and that in armatures with large pole-pitch and short length of core,

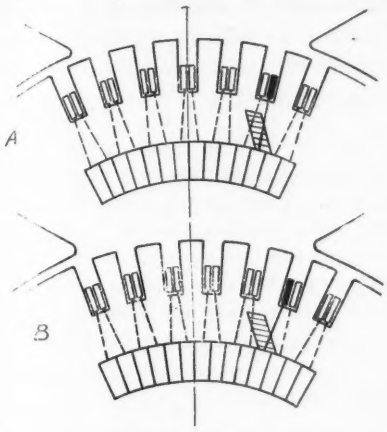


FIG. 3.—ARMATURE WITH TWO COILS PER SLOT, SHOWING POSITION OF ARMATURE WHEN THE TWO COILS ARE BEING COMMUTATED.

the self-induction of the end connections was comparable with that of the conductor embedded in the slots.

In the light of these experiences it is evident that the design of a direct-current machine in regard to sparking is a compromise between a number of conflicting conditions. It is not possible to obtain a formula which will give a strict measure of the commutating qualities of all machines; but by taking into consideration the more important conditions which effect the sparking it is possible to obtain a formula which will give fairly accurate results when applied to machines similarly

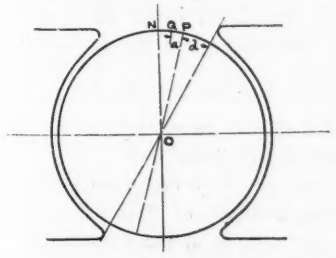


FIG. 4.—POSITIONS ALONG POLAR GAP.

designed, and which will give some idea of the sparking when applied to machines of widely different design. Such a formula, when it has been applied to a number of machines of different types, so that the allowable values for the sparking constant have been determined, can be taken as a fair working formula, and can be placed in the same category as empirical formulas for determining the regulation of alternators. Such formulas are not intended to reduce the designing of machines to mere slide-rule work, but are intended simply to give an idea as to the experimental results to be expected from individual design.

As outlined above, the most important conditions to be taken into consideration are the self-induction pressure of the commutated coil and the inequalities introduced by the conditions of commutation.

I—SELF-INDUCTION PRESSURE.

This is given by the formula; V = self-induction of one coil times number of coils commutated in series times current in coil times frequency of commutation.

The self-induction of one coil = (self-induction of one conductor embedded in the slot + self-induction of one end connection) times (number of turns per coil)^2.

The self-induction of one conductor embedded in the slot $= l\ k$, where l is the length of the core and k is a constant depending on the dimensions of the slot.

By determining the self-induction of a large number of slots we find that this constant k can with sufficient accuracy be taken as a function of the ratio

$$r = \frac{\text{Width of slot.}}{\text{Depth of slot.}}$$

A curve can be plotted connecting r and κ, and determined experimentally from tests on a number of armatures; such a curve is shown in Fig. 1.

Take the self-induction of the end connections = length of end connections times constant c'. And as the length of end connection is approximately proportional to the pole-pitch this can be written with sufficient accuracy $= p\ c$.

Hence the self-induction of one coil $= n^2\ (l\ k + p\ c)$.

The number of coils commutated in series N is, of course, one in a parallel or lap-wound armature, and equal to the number of pairs of poles in a series or wave-wound armature.

The current per coil I in a series or wave-wound armature is equal to one-half the total current in the machine, while in a parallel or lap-wound armature it equals the total current divided by the number of poles.

The self-induction pressure of the commutated coil is then given by

$$V = n^2\ (l\ k + p\ c)\ N\ I\ f.$$

Where f = frequency of commutation = number of commutator bars times speed in revolutions per minute.

The width of the brush is neglected in calculating the frequency of commutation, since it is found by experiment that within the ordinary limits of practice the thickness of the brush has no effect on the operation of a machine, unless the current density is excessive. The probable explanation of this is that a thicker brush gives more time for commutation to take place; but it means that more coils are commutated at the same time, thus increasing the self-induction effect. These two effects apparently counterbalance each other to a great extent.

II—INEQUALITIES DUE TO CONDITIONS OF COMMUTATION.

These are due to the use of a few slots; more than one coil per slot; and to dead coils.

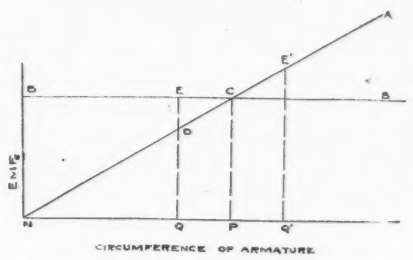


FIG. 5.—CALCULATION OF INEQUALITY.

If there is only one coil per slot the use of few slots does not in itself affect commutation, unless the number of slots is extremely small; for though the slot may move through quite an appreciable arc while the coil is being commutated, the conditions are exactly the same for every coil when it is commutated. So there is no tendency to inequality in the conditions, and if the brushes can be set so that one coil can be commutated satisfactorily then commutation will be satisfactory all round the armature.

But if the number of segments is extremely small, say less than six per pole, then the coils will move in such a widely varying magnetic field, and will come so

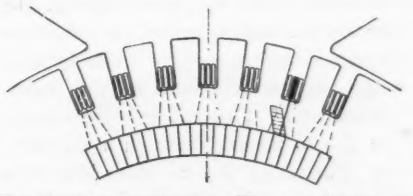


FIG. 6.—ARMATURE WITH TWENTY SLOTS PER POLE AND THREE COILS PER SLOT.

close to the strong field under the pole-tip while it is being commutated, that the local currents under the brush are liable to produce marking of the commutator bars, even if the brushes apparently do not spark. Of course this is only important in very low-pressure machines; it need not be taken into account in the sparking constant. It is sufficient to say that the number of commutator segments

in the polar-gap, that is, the arc between the two pole-shoes, must never be less than two and should generally be three or more.

With several coils per slot inequalities are introduced:

1. Due to the different self-induction of the different coils.

2. Due to commutation under different conditions.

The self-induction of all the armature coils will be the same when there are only two coils per slot, as it is obvious that the configuration of the conductors and neighboring iron is the same for both coils. But when there are three or more coils per slot the self-induction of the various coils will vary, as they occupy different relative positions in regard to the iron; the self-induction of the centre coil will be less than the self-induction of the outer coil. Investigating conditions at the point of commutation in a modern generator by means of a pilot-brush, it is found that in practically all cases commutation goes on at point where there is no result-

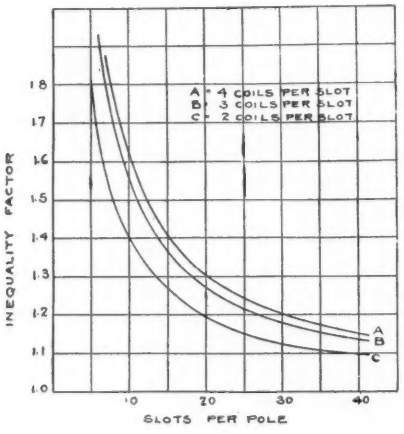


FIG. 7.

ant magnetic field; that is, at a point where the armature field just counterbalances the field due to the magnets. In other words, there is resistance commutation; the armature current is commutated by the varying resistance of the brush, rather than by a reversing electromotive force due to passing through a magnetic field. This being the case there is need to consider only the self-induction of those coils which have the greatest self-induction. If these are commutated satisfactorily by means of the varying resistance of the brushes, then those coils which have a smaller self-induction will also be commutated satisfactorily. Hence the variation in the self-induction of the coils need not be considered and in the formula all that needs to be considered is the self-induction of those coils which have the greatest self-induction.

The chief inequality introduced into the commutation by having more than one coil per slot is due to the various coils in the slot commutating when they are in different magnetic fields. This is evident from Fig. 3, which shows the position of the armature when the first and the last coil in the slot are commutating. If the

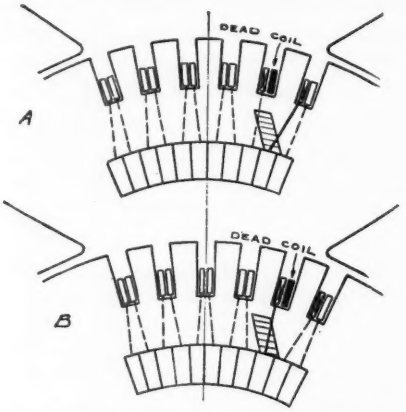


FIG. 8.—ARMATURE WITH DEAD COIL, SHOWING POSITION OF ARMATURE WHEN THE COILS NEXT TO DEAD COIL ARE BEING COMMUTATED.

brushes are set so that the magnetic field is right for the first coil it will be wrong for the last one, and *vice versa*. So whenever the machine is loaded to its limit the commutating conditions will be so bad for some of the coils that in time some of the commutator bars will become pitted and there will be that well-known regularly recurring marking of the commutator bars.

The question now is how to take this inequality into account in the sparking formula. To do this, make the assumptions that the magnetic field varies uniformly from the neutral point to the pole-tip, and that in order to obtain perfect commutation it is necessary to move the brushes from a position at the neutral point at no load to a position half-way between the neutral point and the pole-tip at full load. Calling the distance between the neutral point and the pole-tip 2 *d*, and assuming the brushes fixed on the line OP half-way between the pole-tip and the neutral point, then if any coil is commutated when it is at Q distant *a* from P, then it will only commutate perfectly a load $l - \frac{a}{d}$.

Just what this assumption means can be seen from Fig. 5.

Abscissæ represent positions along the polar-gap corresponding to Fig. 4, and ordinates electromotive forces.

The line NA gives the electromotive force induced at various points by the conductor moving in the field due to the magnets.

CP, the ordinate of the line BB, gives the electromotive force necessary to reverse the full-load current I in the coil.

If the coil is commutated at the position Q instead of at P, then the commutation conditions will be perfect only for a current $\frac{DQ}{CP}$. I. Hence we assume that if we have several coils per slot, and that if in consequence of this we have to commutate some of our coils in a position EQ and E'Q', then the current which the machine will carry without sparking is reduced in the ratio $\frac{DQ}{CP}$, that is $\frac{NQ}{NP}$.

It is very easy to figure out just what this inequality amounts to in any particular case. Take twenty slots per pole, three coils per slot, pole-face = seventy-five per cent of pole-pitch.

There are 2.5 slots between the neutral point and the pole-tip. Assuming that the conditions are perfect for the centre coil, the outer coils are 0.333 slot-pitch out of this most favorable position. And 1.25

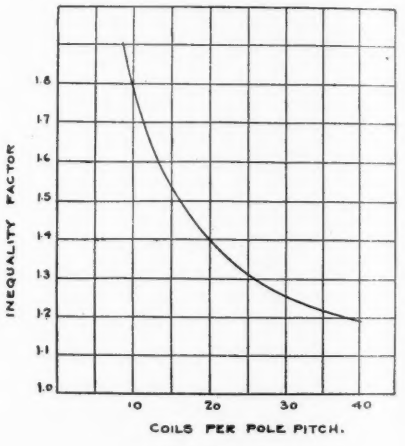


FIG. 9.

slots corresponding to variation from no load to full load, hence an equality of 0.333 slot-pitch gives an inequality factor $\frac{0.333}{1.25} = 0.26$. Hence the sparking constant should be multiplied by the inequality factor 1.26.

Curves can very easily be plotted for different numbers of slots per pole, and coils per slot, in order to facilitate the calculation of this inequality factor.

The assumptions on which this calculation is based are to a great extent rational, and though we can not pretend that the calculation has a rigid basis, yet it is probably as correct as the other sparking calculations, and used with discretion it gives fairly reliable results.

The inequality introduced by using a dead coil on the armature is similar to that due to several coils per slot. The

dead coil produces a break in the uniformity of the winding; and if the position of the brush is correct for commutation of the coil immediately on one side of the dead coil then it will be just one segment out of the correct position for the coil immediately on the other side of the dead coil. The inequality introduced can be calculated, and allowed for in the sparking constant exactly in the same way as we allow for the inequality due to several coils per slot. Assuming that the brush is in a mean position then it will be just half a segment out of position for the two coils which are next in position to the commutated coil.

Making the same assumptions as before; if there are n commutator segments per pole, and if the pole-face = seventy-five per cent of pole-pitch then the inequality is equivalent to $\frac{8}{n}$. Thus if there are twenty segments per pole a dead coil produces an inequality equal to forty per cent of the load, and the inequality should be introduced into the sparking constantly by the factor 1.4. A curve can readily be plotted between the inequality factor and the number of coils per pole. Such a curve is shown in Fig. 9.

Combining all the different factors which affect sparking we get our complete formula for a sparking constant.

$$C = n^2 (l k + p c) NI f PQ.$$

P being the inequality factor resulting from a number of coils per slot.

Q being the inequality factor resulting from a dead coil.

This formula is not put forward as being scientifically exact, but as an empirical formula which has gradually been built up as the result of experience, different terms having been added to the formula from time to time as it was found necessary to take different conditions into account. As the formula stands it gives excellent results. When we know the value of C we can allow for the particular design of machine we are dealing with.

The relative values of C that have been found allowable in different cases are somewhat as follows:

Two-pole, twenty; four-pole, series wound, thirty-five; six-pole, fifty; four-pole, multiple wound, thirty; six-pole, thirty-five; gradually increasing to twenty-four-pole, multiple wound, fifty.

Of course, all the machines in each class are designed alike; that is, they have approximately the same densities in the teeth, and have the ratio of ampere-turns per pole on the armature (armature reaction) to the ampere-turns required for the teeth and air-gap approximately constant. If these vary much it is impossible to get consistent results.

The brush-gear and the current density in the brushes also play an important part in the sparking. If the brush-gear is weak mechanically, or if the commutator is in bad condition, the machine is sure to spark. And with ordinary grade carbons the brushes will usually glow when the current density reaches fifty amperes per square inch.

The shape of the pole-tips has some effect on the operation of the machine. But so long as they do not come too close together and so long as they are shaped so that there is a commutation field which varies gradually, the exact shape need give us no concern.

The density in the armature core (behind the teeth) has also a considerable effect on the allowable sparking constant. If the core is highly saturated it can be run with a constant considerably higher than if it is unsaturated.

Assuming that all these conditions are uniform and satisfactory, the variation in the allowable value of C shows that the formula does not take into account all the conditions that affect the sparking, so the formula must be used with considerable discretion. It can not be claimed that the formula is in any way accurate, but it certainly is an empirical working formula, capable of giving very good results when carefully used, and as such it is put forward.

Terrestrial Magnetism.

The results of the magnetic observations made by the Coast and Geodetic Survey between July 1, 1902, and June 30, 1903, are given in a bulletin issued by the Department of Commerce and Labor, Washington, D. C. This is edited by L. A. Bauer, the inspector of magnetic work and chief of the division of terrestrial magnetism. The original plan of this survey contemplated one station for every county; hence they would be, on the average, from twenty-five to thirty-five miles apart. Additional stations were to be added in localities where special disturbances were observed. At the present time observations have been made, at 430 stations, distributed fairly well throughout the country, in the Philippines and Porto Rico. The usual methods made were declination, dip and intensity. Special investigations were carred out by Dr. Bauer, who tested a new Lloyd-Creak dip circle, intended primarily for use on shipboard. During February of 1903 Dr. Bauer also established stations on the ice in the Straits of Mackinac, where observations were made. The observations have been reduced and are arranged alphabetically in tables, there being a table for each state where observations were made. The bulletin also contains a description of each station.

THE WAY TO BALANCE THE PLATES OF A WIMSHURST ELECTRICAL MACHINE.

BY JOHN M. BLAKE.

First, we should have the rim concentric with the hole. We accomplish this by drilling the hole first, and sweeping our diamond or steel cutter from it, as a centre. This alone, however, is not sufficient to obtain a balance, such as we need for safe running at high speed. The reason is that glass plates almost always vary in thickness. One side may be thin, and the other side thick; and we are likely, therefore, to find our plate badly out of balance.

After an experience with this disadvantage, the writer effected a cure as follows: cut sectors of the shape desired out of tin-foil, and also a number from tea lead and thicker sheet lead. Of the thicker sectors we take as many as may be required to make the plate balance. These may be put in a bunch on the lighter side, and be held there by a string clip, while at the same time a similar clip is attached to the opposite, heavy side, to eliminate the weight of the first clip. Next, we distribute the sectors each way from the lightest point, fastening them in their permanent places with soluble glue. We have now made a first approximation to a balance.

We repeat with thinner sectors, and eventually we may succeed in getting the full number of sectors in their proper places, and have at the same time a perfect balance. We have thick sectors on the light side of the plate, and thin sectors on the heavy side of the plate.

During this work the plate is fastened on its hub, which must turn easily upon the shaft. Furthermore, we must jar the shaft at each trial, with a stick or mallet, to make the light side of the plate come uppermost. This jarring is essential toward the end of the operation.

A machine with plates thus properly balanced can be run at a speed that may more than double the output of an unbalanced machine.

Massachusetts Institute of Technology.

The April issue of the *Technology Review*, published quarterly by the Massachusetts Institute of Technology, Boston, Mass., describes the course in industrial chemistry offered at that institution. In this course the processes are carried on in the laboratory in such a way as to determine with considerable accuracy many of the factors necessary to form an opinion as to the relative economy of various commercial methods. The different means used for applying electricity to the production of chemicals are taught, and factors affecting the cost are determined.

A Large, Modern Paris Generating Plant.

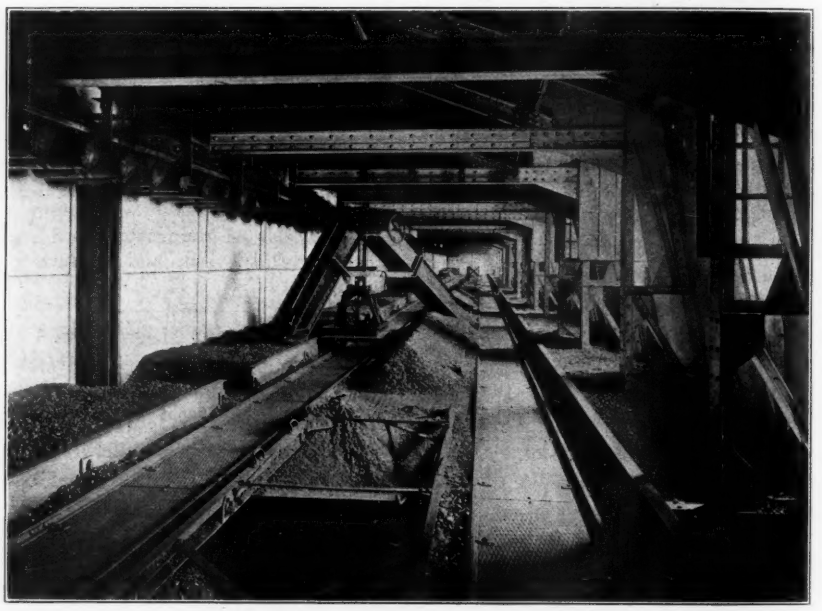
By C. L. Durand.

ONE of the largest as well as a most interesting Paris (France) generating station is the large plant which has been erected within the last few years by the Compagnie Parisienne de l'Air Comprimé. It is located in the central part of the city on the Quai de Jemmapes in a three-story building, and is equipped with the most modern types of machines and boilers. The current from the central station is sent through the feeders to three substations, which in turn supply the city mains in various quarters, both for lighting and motors. The following data were furnished through the courtesy of M. George Iess, one of the managers of the company.

The system of coal supply and the disposition of the boiler room are somewhat novel. In the present case the dynamo room lies on the ground floor. Above it is the boiler room which occupies about the same area. On the top floor is the room containing the coal bunkers. By this arrangement the coal is fed from the bunkers by means of a series of vertical coal chutes or rectangular columns on to the floor of the boiler room in front of the furnaces.

This disposition was adopted in order to allow of building the station on a comparatively small piece of ground, seeing that it is located in the centre of the city, contrary to the usual practice, and the cost of real estate is of course very high. In carrying out this arrangement the station has been designed on the most improved plan and the system of coal distribution is especially well laid out and is almost automatic. The station is located on the St. Martin Canal, which penetrates into this quarter from the Seine. Coal can thus be brought very conveniently upon barges, and is unloaded upon the wharf in front of the station. Most of the coal-handling operations are carried out by a system of bucket conveyers, horizontal and vertical, which are operated by electric motors. The coal is unloaded from the barges and dropped into a pit on the edge of the wharf. From the pit a tunnel runs into the basement below the station. The coal drops into the buckets of a horizontal conveyer which runs in the tunnel. The station is provided with a vertical conveyer which runs from the cellar to the top of the building.

The first conveyer brings the coal from the wharf to the middle of the basement and drops it automatically into the elevating conveyer which takes it to the top story. The whole operation is carried out with but very little attention, as both conveyers are motor-operated. On arriving at the top of the building the coal is fed into bunkers which lie above the rows of boilers. The boiler room contains two ranges of boilers which face in opposite directions toward the sides of the building. The illustration shows one of these. Two ranges of coal bunkers are thus required, one lying above each set of boilers. The upper floor containing the bunkers is divided longitudinally into two rooms, each having a row of bunkers lying flush with the floor, which feed the coal down in front of the boilers. This disposition will be observed in one of the illustrations which shows the method of handling the coal after it reaches the top story. The view is taken in one of the rooms, while a similar gallery lies parallel to the first on the other side of the building.



UPPER FLOOR, SHOWING COAL BUNKERS AND CONVEYERS, COMPAGNIE PARISIENNE DE L'AIR COMPRIMÉ, PARIS, FRANCE.

The coal bunkers run along the whole length of the building, corresponding to the boilers. The coal descends from the bunkers by the vertical columns, which the second illustration shows. To bring the coal to the bunkers the following system is adopted. The coal on arriving at the top by the vertical conveyer in the centre of the building is poured automatically into the buckets of a conveyer which passes transversely across the middle and at right angles to the first. Over the coal bunkers will be observed a set of lateral conveyers which run through each gallery. These are disposed so as to run from the central passage along each of the side galleries. The coal thus passes from the vertical conveyer in the shaft, drops into the cross conveyer and the latter unloads it into the buckets of the conveyers in the galleries. A movable coal chute (noticed in the foreground) is disposed to run upon a track which lies above the bunkers. The buckets of the conveyer can be tripped up and emptied at any point into the movable chute which thus feeds it into any one of the bunkers. One movable chute suffices for each of the galleries. The conveyer system includes an automatic scale which weighs the coal as it passes and records it upon a meter.

The boilers of the station have been installed by the Delaunay-Belleville Company, one of the leading French constructors. They are of a type which uses but a small quantity of water, and for this reason the administration authorizes the use of these boilers even in the case where inhabited buildings are at a distance within ten metres, without being obliged to build a special protecting wall such as is required in Paris in the case of boilers which use a large volume of water. In the present building, where the boilers are placed in the upper story, it would be

impracticable to build such a wall. The boilers which have been adopted in the present case are composed of a set of tubes which lies directly above the furnace grate, combined with a second set which serves as a feed-water heater. Each set of tubes is surmounted by a serpentine for drying the steam.

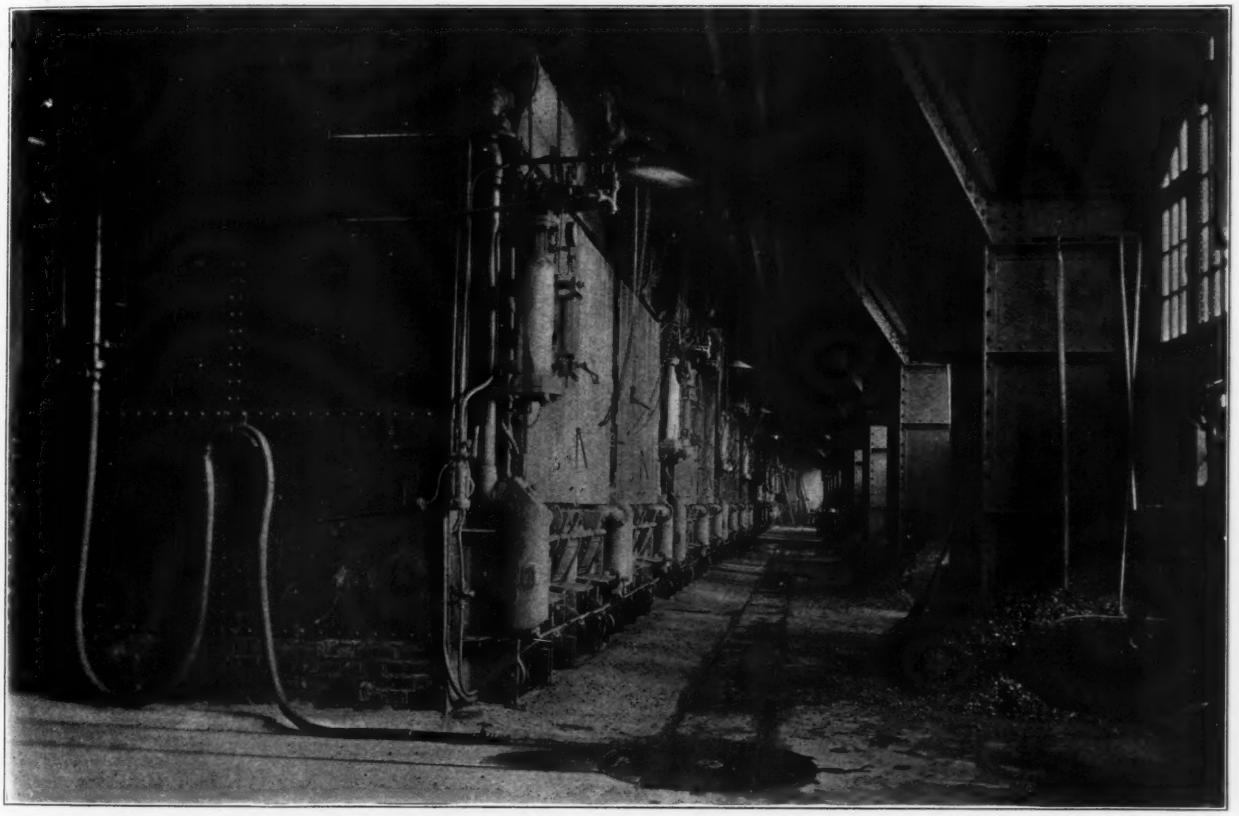
Four boilers constitute a battery and are used to supply one of the main dynamo groups. These four boilers are designed to produce 10,000 kilogrammes of steam per hour with the kind of semi-bituminous coal which is commonly used in the Paris stations. The grate surface of one boiler is 5.23 square metres, or 20.92 for each battery of four boilers. The total heating surface of a battery is as follows: main tubes, 530.08 square metres; drying tubes, 59.12; heaters, 276.32, or a total of 865.52 square metres. The dimensions of the boilers are sufficient to allow of shutting off one boiler of each battery in case of need, when the remaining three will suffice for one of the dynamo groups.

As the boilers take but a small volume of water, they are supplied with a continuous feed, and to this end are furnished with Belleville pumps. Each battery of boilers is equipped with two of these pumps, one of which is sufficient for the total supply. Above the boilers, which are placed back to back, are located the cubical water reservoirs, and the system is completed by a set of chimneys built of sheet iron of two metres diameter and twenty metres height.

A view of the main dynamo room, which lies on the lower floor of the building, will be seen in one of the illustrations. The generating units are formed of vertical engines which are direct-coupled to the dynamos. At the farther end of the room is the large switchboard, which is placed in a gallery overhead and reached by two staircases. In general appearance the dynamo room of the Quai de Jemmapes station is one of the handsomest in the city. It has a well polished hardwood floor, and the machines are protected by balustrades of an ornamental character. All the groups are alike in character. Both engines and dynamos have been built by the Société Alsacienne de Constructions Mecaniques, which is one of the leading electrical firms of the country and has a large works at Belfort. A platform surrounds the engines to give access to the cylinders, and it is reached by a staircase; a second and smaller platform lying above the first allows of reaching the tops of the cylinders.

The engines are built on the Corliss system and are compound condensing. They run at a speed of seventy revolutions per minute. The high and low-pressure cylinders measure 800 and 1,300 millimetres, respectively, while the stroke is 1.2 metres. The average steam pressure in the high-pressure cylinder is eight kilogrammes per square centimetre, and the engines are designed to give 1,200 horse-power when working at this pressure. The revolving part of the dynamo is mounted upon the main shaft, which projects upon this side, and lies next the low-pressure cylinder. On the other side of the engine next the high-pressure cylinder is mounted the flywheel, which measures 5.7 metres in diameter and weighs thirty-four tons. Both cylinders are steam-jacketed. The high-pressure cylinder is heated by steam coming direct from the boilers, while the jacket of the low-pressure cylinder takes steam coming from the first cylinder. The condensers of these engines are of the injector type. They use an air pump of 800-millimetre cylinder diameter and 440 stroke, which is placed in a vertical position and operated from the engine by a set of levers.

The dynamos form one of the original features of the station. They are of the direct-current type and have been constructed by the Société Alsacienne. These



Boiler Room, Compagnie Parisienne de l'Air Comprimé, Paris, France.

machines differ from most of the usual direct-current generators in the fact that the field is placed in the interior, while the armature of the Gramme ring type lies on the exterior and revolves about the field. The arrangement of the commutator is also quite novel. A set of bars which forms part of the winding is placed around the outer periphery of the ring armature and serves as a commutator, which is thus of unusual size. This disposition will be noticed in the detail view of one the machines.

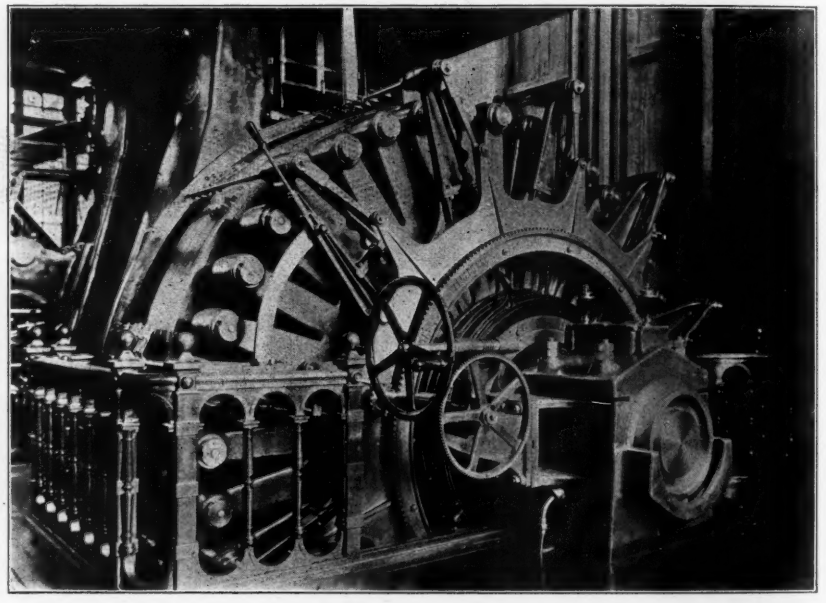
At present there are eight dynamo groups in the station. Each is direct-coupled to its engine. Another generating set of similar construction is now being installed in one end of the station, as it became needed to meet the increasing demand for current. The total number of generating units will thus be nine, and there is no doubt that a further increase will become necessary in the future. The dynamos are built to furnish 1,500 amperes at 500 volts under the usual running conditions and the output is thus 750 kilowatts. When need be, the machines can be run as high as 600 volts, increasing the output to 900 kilowatts. The engines run at the slow speed of seventy revolutions per minute, and as the dynamos are direct-coupled to the engines, it will be seen that a generator of this voltage and capacity would reach a considerable size. On the other hand, the dimensions of the machine had to be kept down as low as possible so as to allow of transporting them by railroad from the shops at Belfort. On this account the present type of generator was chosen.

The exterior armature is the largest single piece, and measures four metres in external diameter. The brush-holder which surrounds the armature is larger than this, but it could be built in several pieces and thus give no difficulty. Some details of the construction of the Belfort generators may be of interest. They are of a type which has been adopted by the Société Alsacienne, and a machine of this kind could be seen at the Paris exposition where it was coupled to an upright engine in the main dynamo hall and formed one of the lighting and power groups. The end view of one of these machines which this illustration presents will indicate the main features. The Gramme ring armature which lies on the exterior is formed of a laminated iron core. It is supported on one side by a star-shaped piece containing thirty-nine radial arms which are cast with the hub. The arms are bolted against one side of the laminated ring. The star-shaped support is an exceptionally fine piece of foundry work and weighs nearly eight tons. The radial arms of the support each carries a steel rod which projects inwardly. The rods are held in the ends of the arms in brass bushings which are well insulated from the casting. The rod passes through the laminated armature ring and carries a nut on the other end by which the ring is firmly fixed to the support.

The laminated ring is formed of sheet steel 0.5 millimetres thick, insulated on one side and well pressed together. A Gramme winding is placed upon the ring core, which is first well insulated. This winding is laid on in a somewhat unusual manner. Copper bars of large section are used to make up the winding and the latter is formed of U-shaped pieces which fit upon the ring. These are slid on to the core from one side. They are joined together on the near side by a set of straight bars so as to form a continuous winding all around the armature. The latter contains but a single layer. The U-shaped bars have a thickness of 2.5 millimetres, while the bars which join the ends are of larger section and carry a slot in each end into which the others are laid in order to form the joints. The bars are then soldered together.

The portion of the bars lying around the outer periphery of the ring is utilized at the same time to form the commutator. To this end it is left bare and the bars have mica insulation between them. They are turned off so as to present a smooth surface. Thus the exterior of the armature forms, in fact, a commutator of exceptional size. This disposition will be noticed in the detail view, with the brushes bearing against the outside of the armature.

As there are twelve poles in the interior field, this allows twelve collecting points for the commutator. The brush-holder support is formed of a large star-shaped piece which carries twelve radial arms, as will be observed. The arms are bolted to the central hub. One of the novel features of the brush-holder is the method of raising and lowering all the brushes at once (copper brushes are used) or giving the desired pressure on the commutator. This is carried out by making the brush-holder rods pivoted in the ends of the arms. The outer ends of the rods are all connected by levers with a second star-shaped piece which lies outside the first and can be turned about the brush-holder support. On revolving this piece the levers act upon the rods, and raise or lower the brushes. This movement is carried out by an endless screw gearing which is operated by a large hand wheel placed in a convenient position. As to shifting the brushes around the commutator, this is not found necessary with these machines, as they are able to run under varying loads with little or no sparking.

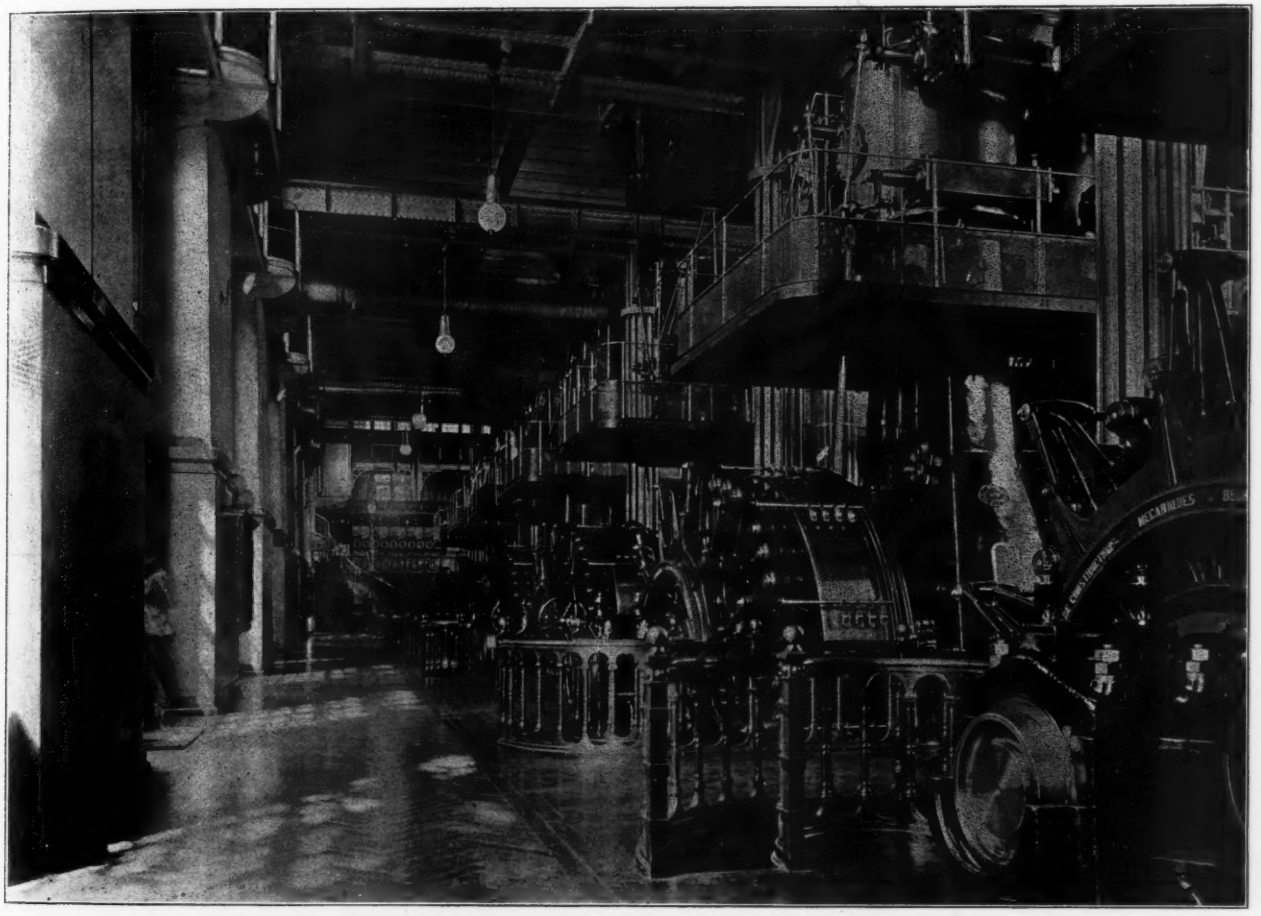


DETAILS OF GENERATOR, COMPAGNIE PARISIENNE DE L'AIR COMPRIMÉ, PARIS, FRANCE.

The internal field of these machines is built in the usual way and carries twelve poles. These are bolted upon a central core which is fixed against the side of the engine. The core and pole-pieces are formed of a low-carbon steel. The pole-pieces are formed with a rather large and expanded pole-face which lies against the inner periphery of the armature and this

combination works under the best magnetic conditions.

The large switchboard of gray marble panels is mounted in a gallery about ten feet above the main floor. The switchboard is disposed in three portions. The central part is used for the different feeders starting from the station, and here are placed the meters and the apparatus for adjusting the voltage on the lines. The two outer parts of the switchboard contain the panels for the generators. They carry the apparatus which



Dynamo Room, Compagnie Parisienne de l'Air Comprimé, Paris, France.

is used for placing the machines in parallel and for regulating the voltage of the different generator circuits. Bus-bars run along the whole length of the switchboard. These, as well as most of the connections, lie in the rear. The bus-bars have a section of 10,000 square millimetres in the heaviest part. The generators are all connected in parallel, and the bus-bars thus receive the whole of the current.

The feeder panels, which form the central part of the switchboard, comprise twenty panels, each of which is used for one of the feeders which leaves the station. These feeders run to the substations which are located in different parts of the city and serve as centres of distribution for the mains. The system of regulating the voltage has to be well carried in the present case, owing to the local conditions. The drop is not the same on all the feeders, seeing that the load on all the substations is not the same, and one of them may be working at full load while the other is running at a light load. This condition would cause a difference in drop in the different feeders, and the substations would receive current at varying voltages, seeing that the main station delivers a constant voltage at the bus-bars.

A convenient method of equalizing the drop has been found, by using feeders which are made up of a number of cables instead of a single one. By coupling the cables of a feeder in series or in parallel, using different combustions, the drop is properly adjusted for the changing loads on the substations. This regulation is carried out by the coupling apparatus which is placed on the feeder panels in the main station, combined with the use of rheostats which give the necessary balancing resistance. The latter come into play especially when there are but a small number of cables in a feeder.

The five-wire system of distribution is used in the present plant. The central station supplies a number of substations (three at present) lying in different parts of the city. The distribution from the central station is carried out at 400 volts. The feeders which pass from the central station to the substations are formed of armored cable laid underground. The substations distribute the current to the city mains in the districts which they supply by cables which are laid generally under the streets.

The current comes in from the central station by the principal feeder and passes to the bus-bars of the five-wire system. The voltage of the distribution system is regulated by boosters which work in connection with a battery of accumulators. The boosters are formed of two machines coupled together on the same shaft. One of these machines works as a motor at constant voltage from the main station. Its load is variable, according to the needs of the circuit. The second machine, which regulates the line voltage, works at varying loads and also at a widely varying voltage.

The latter may vary between 10 and 160 volts. The load on the second machine runs from 0 to 400 amperes. These machines are specially designed to meet the present conditions. Their output is sixty kilowatts at a maximum.

The substation contains four sets of storage batteries which work in parallel on the line and aid in equalizing the voltage. Half of the batteries work on the line, while the other half are being charged. Each battery is composed of 280 cells, making 1,120 cells in all. They are of the Laurent-Cély pattern, constructed by the Société des Metaux. Each set has a capacity of 2,200 ampere-hours and generally supplies 300 amperes for the line. The batteries in reserve can be charged either from the boosters or directly by the current coming from the central station.

The Faraday Society.

An ordinary meeting of the Faraday Society was held on Monday, May 9, at the Institution of Electrical Engineers, London, England, Mr. Bertram Blount in the chair.

Dr. Charles E. Fawsitt read a paper entitled "Studies in Viscosity."

Some Relations of Viscosity to Salt Formation—The viscosity of the mixture of two or more substances in aqueous solution is equal to the product of the viscosities which the solutions of the substances separately have. If, however, the substances act chemically on one another then the viscosity of the mixture is different from the calculated value. By numerical illustrations from cases where a strong acid is neutralized by a strong base, this difference is shown to have a constant value for equimolecular quantities. This value corresponds to the formation of undissociated water from the hydrogen and hydroxylions. The difference between the calculated and observed values in the case where a weak base is mixed with a strong acid has a value which varies with the base in the case of urea and its derivatives appear to vanish.

Part II. Viscosity as an Additive Property—A comparison of the viscosity constants of some urea derivatives and aurides of the fatty series shows that for a difference in the composition of CH_2 there is a corresponding difference in the viscosity constant. There is, however, a pronounced "constitutional" effect as shown by the different values obtained for isomeric substances.

Mr. Blount referred to the difficulties in making accurate and reliable viscosity measurements on which important deductions are based.

Dr. T. M. Lowry discussed the relationship between viscosity and conductivity and conductivity and temperature, and he showed how in the case of very dilute solutions the conductivity-temperature curves converge to zero conductivity at thirty-nine degrees centigrade, just as the viscosity curve for pure water does.

Dr. F. M. Perkin read a paper by A. Fontana and himself on "The Electrolytic Oxidation of Anthracine." The authors have taken up the study of the oxidation of anthracine primarily to ascertain whether it was possible to obtain a good laboratory method for the preparation of anthraquinone. The first attempts were made with solutions in acetone, platinum electrodes being employed. Although oxidation took place in solutions of antracine in acetone, it was not found possible to oxidize more than about fifty-five per cent of the anthracine. Attempts were then made to electrolyze anthracine suspended in twenty per cent sulphuric acid or in caustic alkali to which an oxygen carrier had been added. Various carriers were employed, the most satisfactory being chromium, cerium or manganese salts. The anode consisted of a lead vessel, the cathodes, four in number, were also of lead and were placed in four small porous cells. There was also a lead paddle which was connected with the positive pole, the total anode surface was about six square decimetres, current density one ampere per square decimetre, temperature seventy to eighty degrees centigrade, and electromotive force from 2.5 to 3.5 volts. The yield of anthraquinone was about eighty per cent, and it was not found possible to increase the yield more than one or two per cent above this. It was afterward found that almost equally good results were obtained without a diaphragm. In this case the stirrer one-half square decimetre in area was made the cathode. In discussing the results of their experiments the authors consider that owing to its volatility and the comparatively poor yield a solution in acetone can not be recommended. On a large scale no method in which a diaphragm is employed would be satisfactory, owing to the migration of the So_4 ions from the cathode to the anode side. Thev then briefly review the patents of the Höchst Farben Fabrik, Darmstädter and Martin Moest. Le Blanc criticised Darmstädter's patent, and doubted whether it would be possible to obtain any appreciable quantity of anthraquinone owing to the reduction of the chromate by the cathodic hydrogen. The authors are of the opinion that, to a certain extent, the chromium, manganese and cerium salts act as chromium does when employed in the electrolytic bleach industry, *viz.*, by prevention of reduction. Moest claims, in his patent, to obtain a hundred per cent yield of anthraquinone, the authors have been unable to obtain much more than eighty per cent; they are, however, of the opinion that very likely better results would be obtained on a manufacturing scale.

Mr. Blount suggested the use of thallium salts. He thought the energy bill in this instance might not necessarily be an all-important item.

Dr. Steinhart thought better results would be obtained if the anode solution were removed from the cathode.

Mr. Inglis discussed the effect of the potential difference between the anode and solution.

Mr. Gaster thought the cost of energy was of prime importance. He suggested the use of petroleum as a base for colors instead of tar.

Gutta-Percha in the Philippines.

The bureau of insular affairs of the war department at Washington has received a report from the bureau of government laboratories at Manila, P. I., upon the gutta-percha and rubber situation in those islands. This report deals briefly with the commercial history of gutta-percha and its discovery, and the rapid depletion of the supply in the East India Islands. The last source of gutta-percha developed is that in the Philippine Islands, but here the regions which produce this material for the market are confined to the islands of Mindanao and Tawi-Tawi. The method of harvesting used at present by the natives consists in cutting down the large trees, ringing the trunk, lopping off the larger branches, and then catching the milk as it flows out. This is very wasteful, as but a small part of the milk is secured. Fortunately, however, this process pays only with large trees, so that the smaller ones are not destroyed. This method of harvesting has been prohibited and rules provided for tapping the trees, but these have never been enforced. At the present time, the gutta-percha trees have disappeared from the coast regions, and are along the large rivers.

The various governments with tropical possessions in the east are studying the gutta-percha and rubber situation, with a view of determining proper methods of propagation and harvesting.

The Philippine exhibit at the World's Fair, St. Louis, Mo., will include a good display of gutta-percha and rubber.

A ONE-HUNDRED-MILE TRANSMISSION LINE.[1]

BY ROBERT HOWES.

In the following it is not the purpose to indulge in long explanations, descriptions or theories, but rather to give a brief description of the essential features of the plant, the results obtained and difficulties encountered.

The observations recorded are to be considered as reasonably accurate, but, as you all know, observations in an operating plant have to be made when one has the opportunity, and usually just at the time when he would like to be taking interesting readings, he is so busy with operating features that there is little time to make accurate notes.

The plant considered is that of the Washington Water Power Company, of Spokane, Wash. The power-house is located at the foot of the lower falls of the Spokane river, in the very centre of the city of Spokane. The theoretical head on the water-wheels is about seventy-one feet.

That portion of the plant which furnishes the power for the transmission line is composed of two Y-connected, 4,000-volt, 2,250-kilowatt, sixty-cycle, 300 revolutions per minute, revolving-field alternators, each direct-driven from a pair of forty and one-half inch special turbines, made by the Stilwell-Bierce & Smith Vaile Company, and designed to develop 4,000 horse-power under sixty-eight feet of effective head. The water is supplied to each unit through a steel flume ten feet in diameter and over 500 feet long.

The wheels are governed by Lombard governors, with compensating action modified to meet the demands occasioned by kinetic energy of the water moving in the long flumes. These governors can be relied upon to keep the speed from rising or falling over three per cent from the normal with instantaneous changes of 600 kilowatts at any position of the gates, and will care for small changes of load to within one-third of one per cent of normal speed.

The accompanying diagram gives the important electrical connections. All instruments have been omitted, to avoid confusion of lines, but a fairly complete set is installed. Each generator is supplied with voltmeters, ampere-meters and wattmeters in each leg, and the leads to the step-up transformers also have ampere-meters and a power-factor indicator.

[1] Read before the National Electric Light Association at its twenty-seventh convention, held at Boston, Mass., May 24, 25, 26 and 27, 1904.

By running one of the generators alone on the transmission line a complete set of voltmeters, wattmeters, ampere-meters and power-factor indicator is available. All the electrical apparatus is of General Electric Company's make, the indicating instrument being of the horizontal edgewise type.

The principal exciter is driven from a separate wheel, which is supplied with water from either of the two flumes. An induction motor, not yet in operation, is to be connected to the end of the exciter shaft, opposite the water-wheel, and driven from the transmission leads inside the oil circuit-breakers. It will serve the double purpose of governor and insurance against lack of power for the exciter if the chute-case of the water-wheel becomes partially chocked up. An indicating wattmeter on the induction motor will indicate the choking of the water-wheel by showing that the motor takes more load. The exciter will then be started and the choked wheel cleaned out.

The plant is designed to furnish three-phase current at 4,000 volts for local power and 2,300-volt, single-phase current for local lighting service in Spokane. Any lighting feeder can be thrown on either of the three legs of the Y-connected generator, by means of the type "G" oil switches, and the load on the generators kept balanced. Type "C. R." hand voltage regulators are installed on the neutral or grounded side of each lighting feeder; the voltage being regulated with the aid of a voltmeter compensated for the line loss.

The generator, transmission line and main city switches are motor-controlled and of the type "H" variety. Those on the transmission line and city have automatic overload tripping devices. The city feeders have automatic oil circuit-breaker switches, hand-operated.

The step-up transformers are 750 kilowatts each and of the water-cooled type. They are connected in delta on the 4,000-volt side, and in Y on the high-tension side, the neutral connection being grounded at the power-house. The high-tension winding is for 34,700 volts, taps being brought out for 26,000 volts also, thus giving a choice of 60,000 or 45,000 volts line pressure. Two spare transformers are installed, and the switching arrangement is such that one of the spare ones can be cut in to replace either of the three in use without shutting down. The second spare one can be connected on any phase by shutting down about one minute.

Three banks of lightning arresters are installed on the line; one at Spokane, one at the end of the line and one about twenty miles from the end of the line.

The main line is ninety-eight miles long at the farthest substation and has three short branches at present. Low-tension current is transmitted about two miles farther up the cañon, making the total transmission just 100 miles.

On leaving the power-house, the line goes through the city streets for three and one-half miles; the poles used being from forty to eighty-five feet long, in order to get above everything that might be interfered with. Wherever it crosses other lines, grounded wires are strung over them several feet below the transmission line.

Leaving the city, the line follows a county road for about 24.5 miles, till it reaches the Cœur d'Alene Indian reservation. Across this, a distance of 24.8 miles, almost all in heavy timber, a private right of way was obtained and cleared of all trees and brush. All trees outside the right of way, liable in falling to reach the line, were also felled. At one point in this portion, the line crosses the St. Joseph river, where it empties into the Cœur d'Alene lake. The river runs close to a bluff on the west, while on the east side there is a marsh and the neck of an inlet. At high water several feet of water stand from bluff to bluff. To span this would require a span of 3,300 feet, so resort was had to setting the poles on a cluster of five piles. The centre one being driven about six feet lower than the others, a socket was formed in which the pole was firmly clamped with heavy iron bands. By this means the longest span was reduced to 474 feet across the river channel, the wires being far above the smoke-stacks of the steamers that navigate the river. No. 0 B. & S. hard-drawn copper wire was used here for further security, against a wire breaking. A row of single piles with a plank walk was placed across the marsh under the line, for patrolling purposes. Thus far this construction has proved most satisfactory.

Leaving the reservation, the line follows up the valley of the Cœur d'Alene river and the south fork of the same to the mining region. It is largely on private right of way, but follows county roads in part, and goes through a mixture of swamps and meadows—sometimes several feet under water—timber-covered mountains, steep rocky mountain sides and around rocky cliffs. As far as possible it was considered best to avoid proximity to towns, railroad tracks, etc., where the youth with a 22-calibre rifle

likes to walk and practice shooting, for the insulators offer a tempting target to those of a mischievous nature.

The poles of the present line are set thirty-five feet from the north or westerly side of the 100-foot right of way, leaving room for a duplicate line on the other side.

The standard pole is thirty-five feet long, of winter-cut cedar, twelve inches at the ground line and eight inches at the top. They are set six feet in the ground. Special lengths are used in hollows at bottom of ravines, etc., to avoid making too great a change in the slope of the wires on any one insulator, also at railroad crossings and in villages.

The wires are of No. 2 B. & S. medium hard-drawn copper, and are placed to form an equilateral triangle forty-two inches on a side. The upper insulator is set on the top of the pole, the others at either end of the cross-arm. A complete set of three partial transpositions is made in each section where the condition varies in paralleling telegraph, telephone lines, etc.; otherwise in every mile.

A private telephone line is run on the side of the poles below the power line and is transposed every few spans. The insulators used are of the double-petticoat type, thirteen-inch size, and are mounted on a metal pin. This pin is described by Mr. D. L. Huntington in the Transactions of the American Institute of Electrical Engineers for April, 1903, p. 453, and has given entire satisfaction to date.

The substation buildings are of brick. The high-tension wires, entering near the top, go directly to knife-disconnecting switches, set on a gallery, thence to the transformers on the ground floor. One transformer of the three-phase type is used. The secondaries pass from a transformer to a switchboard, carrying oil circuit-breakers, recording wattmeters and indicating instruments, thence to the customers' circuits. The half-voltage taps shown on the diagram are for starting purposes only, for synchronous motors. There are eight of these substations, six of which have been in continuous use since starting. Besides the above, there is a substation recently built about eleven miles from Spokane, where power is taken from the transmission line and the voltage stepped down to 23,000 to supply the lines of an interurban railway thirty-three miles long. The railway company uses the power through rotaries to supply the trolley with 600-volt direct current.

Several miles of long-distance telephone line parallel the transmission line at a distance of about forty feet, and one of the telephone company's engineers was much worried, fearing trouble with the operation of these lines. Three days after the transmission was in operation, he asked when the current would be turned on, as he wished to notice how much the change was. Upon learning that the current was on, he admitted he could not detect it in the operation of the telephones. There is very little sound on the private telephone line from induction unless one wire becomes grounded, when it becomes almost impossible to understand a person at the other end.

A rather peculiar loss of from one to six feet of head in the draft tubes is encountered at ordinary height of the river. The centre of shaft is then about eighteen feet above tail-water. Not far above the intake to the power-house the river divides into several channels, and falls over numerous small dams and cascades (composing the "upper falls") about sixty feet, reaching this level a few hundred feet above the intake. There being no quiet water whatever, considerable quantities of air seem to be taken into the flumes with the water, and no doubt are held there under pressure as the water flows down the flumes, to be instantly released upon passing through the wheels into the partial vacuum. This, no doubt, explains a part of the loss of head.

Another peculiar phenomenon is noticed every time one of the 4,000-horse-power wheels is started, of which the writer has found no satisfactory explanation, and would be glad to hear one. The following characteristic observations were recorded by him: the pressure at centre of shaft, according to gauge, being noted as twenty-four pounds and the vacuum in draft tubes being zero, the gate of the wheel was opened slowly. Full speed was reached in about one minute, the gate being nine per cent opened. The vacuum was noted as rising rapidly. The speed remained steady for two or three minutes and the vacuum increased to ten inches of mercury; suddenly the wheel slowed down twenty per cent, the vacuum continuing to rise to about thirteen inches of mercury, where it remained practically stationary. The wheel continued to run at steady speed and twenty per cent low until the gate was further opened, it requiring sixteen per cent gate opening to bring the wheel back to speed. The pressure gauge showed a loss not to exceed one-tenth of a pound, while the vacuum remained about the same.

The power-house being ready before the line was completed, seventy-seven miles of line were first tested. All switches were closed and the generators started slowly from rest. The speed was gradually increased, the connections having been made for 60,000 volts pressure. The pressure was brought up to 42,000 volts and then cut down slowly to zero without any indications of trouble.

Next morning the machine was started again in the same manner, the voltage being raised to about 68,000 volts for a short time, and then lowered to about 58,000 or 60,000 volts, and held there all day while the entire line was patrolled and found to be in good condition. Along the line a discharge could be heard at a large percentage of the insulators. With 58,000 volts on the line, the amperes shown on the generator were 230 in each leg, while the wattmeter indicated twenty-five kilowatts per leg. This would show the charging current to be approximately fifteen amperes, while, after the step-up transformer loss was deducted, the remaining energy lost in the line would not be over ten kilowatts per wire, or a total of less than thirty kilowatts. In this test only one set of lightning arresters was connected, they being at Spokane; each division of the set was composed of twenty-four General Electric 2,000-volt, double-pole arresters connected in series, thus forming ninety-six spark-gaps from each wire to ground. A steady stream of sparks could be noticed through the first few air-gaps. These became less frequent as the number of gaps crossed became greater, and before reaching half-way down the arresters the sparks were no longer visible. The leading current exerted such an exciting effect on the generator that the exciter voltage had to be reduced to eighty-five volts and all the generator fields resistance cut in, giving an exciting current of about fifty amperes, whereas, with the generator half-loaded with non-inductive load, the exciter was run at 115 volts with the generator rheostat handle in about central position.

After this test the line was shut down for four days, the transformers were connected to 45,000 volts line pressure, and the first substation, seventy-nine miles from Spokane, cut in. The voltage was brought up to 43,000 volts, and simultaneous volt readings were taken by means of telephone, the voltage being very steady. The voltage indicated at the substation was a little over 44,000. The voltmeters were new, but were not compared; however, the error should not have been two per cent. The ampere-meters in Spokane on the 4,000-volt side of the transformers indicated 120 amperes, giving about 10.5 amperes for charging current at this volt-

age, there having been two more miles of line cut in and also an unloaded transformer and bank of lightning arresters at the substation since the test at 58,000 volts.

During the first test the neutral wire was not grounded at the power-house, and the floating around of the neutral point was plainly noticed on the lightning arresters, the sets connected to the three wires showing considerable difference, sometimes one being most active and then another. Grounding the neutral wire stopped the greater part of this effect, although a slight varying difference still seemed to exist.

As induction motors were started, the amperes supplied to the step-up transformers decreased until a minimum reading of about ninety-five amperes was reached. The kilowatts were not observed, owing to the generator furnishing current to the city as well at this time, and the proportion of the total supplied to each could not be accurately obtained. After this time, adding more load increased the current, accordingly the minimum current is about eight and one-third amperes for seventy-nine miles of the line at 43,000 volts.

The work was rapidly pushed to completion and the substations were put in operation, each substation being put into service as soon as the line reached it. The power was cut off only long enough to make connections to each piece of new line. Accordingly, no opportunity to test the charging current and the kilowatts of the complete line was had; for one could never be sure that all the load was off at the various substations. From two of these current is supplied for lighting purposes, the towns of Wardner and Kellogg being lighted from one.

At the time of writing, unity power-factor is usually reached with a load of 1,450 kilowatts. The current in the line is then about 18.5 amperes per mile. Four 300-horse-power induction motors, one 240-horse-power synchronous motor, and several induction motors of smaller sizes, are in operation on the line. One of the 300-horse-power induction motors is supplied from the substation at the end of the line, and is direct-connected to a hoist which is almost in constant use. During the first two months this had to be run entirely unbalanced. The effect of this hoist upon the regulation of the line was at first very serious. The motor is a three-phase General Electric, built for 514 revolutions per minute, 2,080 volts and sixty cycles. When the load on the line was light and this motor was started, it would throw a heavy inductive current on the line, increasing the power-factor instantly, leaving the generator much under-excited, and causing the voltage to drop accordingly. To this had to be added a drop of about one or one and one-half per cent, due to drop in speed. The speed would be just about recovered when the load would come off again, restoring the power-factor and excitation to the generator, while the speed would rise about as much as it fell on starting the motor, causing the voltage to go slightly above normal. Ordinarily, the voltage at Spokane would fall about ten or twelve per cent and rise two per cent from normal, while extreme cases were nearly twice as bad. The voltage at the end of the line would in general vary about 1.6 times as much as it did at the power-house. This action continuing every two or three minutes, needless to say, made the power unsatisfactory for lighting purposes, while the speed variation of the induction motors was enough to bring forth severe complaint where they were used to run milling machinery requiring a very constant speed. Even the synchronous motor, judging from the attendant's account, would start to fall out of step, slip over a few poles, and again get in step, but causing much anxiety. After a day or two of this, a man was put in constant attendance on the generator rheostat, and the writer went to the end of the line to study conditions and see what could be done. He found that the motor as then handled took about 275 kilovolt-amperes for the first point on the controller. The operator would then move the handle rapidly, bringing the kilovolt-amperes up to 400 or 500, make the run and shut off quickly. The time of raising the car from the 300-foot level was twenty-five seconds, and from the 600-foot level was forty-five seconds. It was noted by comparing recording voltmeter charts that the attendant at the switchboard in Spokane could do little to keep the voltage from falling, but would bring it back very quickly.

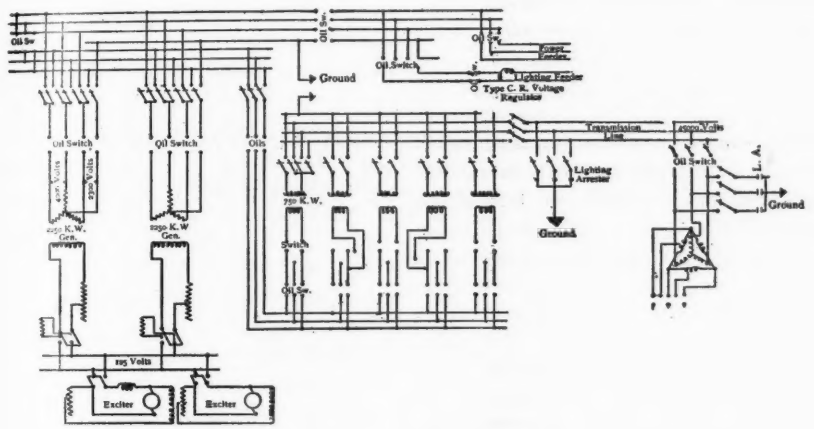


Diagram of Electrical Connections for 100-Mile Transmission Line.

When the motor was cut out the voltage would rise nearly as much as it had dropped before. However, the general effect was much improved. It was found that the controlling rheostat of the motor was too small to stand regulating the speed of the motor for any considerable time, so, as a temporary makeshift, a resistance was made of iron wire and inserted in the circuit between the starting box and the rotor. This had the effect of cutting down the kilovolt-amperes taken at the first point to about 175, and the operator could then move the controller handle more slowly. The first instantaneous drop in voltage was much reduced, and the attendant at the power-house had a chance to hold the voltage nearer normal. With this condition the voltage would usually fall at the power-house about six or seven per cent and would rise nearly as much above normal. While this gave pretty poor lighting service, it did not seriously interfere with the motors. This arrangement, however, has the bad feature of running the motor at a slower speed and so doing only the work of a smaller motor. This is not serious while operating from shallow shafts, but would be unsatisfactory for deeper workings, which will be worked in the future. Accordingly, the writer recommends for such requirements a rheostat large enough not to overheat when running with any part of it in use, the first point to give a current nearly as small as that taken by the motor with the rotor open-circuited. The second point would increase the current about thirty per cent, the next thirty more, the remaining ones to give more

gradual changes. The motor would not start until the third, or if heavily loaded, perhaps the fifth, point. The controller handle should also have a time relay device, making it necessary to consume about three seconds between the first and second points, two between the second and third, and one for the next, also a smaller time limit for cutting out these points. An emergency switch should be provided, so that the operator could cut off the current instantly, if necessary. This would enable the power-house to care for the small changes and keep the voltage near its standard there, the line loss being the principal thing left to contend with.

A large water rheostat was installed at Spokane and used in connection with the transmission line, and was found to be of use on light loads; but when the power-factor reached 100 per cent it did little good and could be cut out. It was hoped that a voltage regulator ordered would be installed in time to record the results herewith, but at time of writing the regulator had not arrived.

A suggestion made, but not tried as yet, is to install a large synchronous motor at the end of the line, with no load except its own exciter, and install one of these regulators to operate on the field of this motor. If the line voltage dropped, the regulator should strengthen the motor field and throw a leading current on the line. If the voltage rose, the field should be weakened to throw a lagging current on the line. The objection to using a motor installed for other purposes is that the motor would often be shut down, and would be largely out of the power company's control.

It may be of interest to note that while the line has been in continuous operation for over seven months, the circuit-breaker has been tripped only eight times, excepting when arrangement for a short shut-down has been made with all parties interested. Of these eight times, two were caused by accidental short-circuits on the line, made by the company's workmen; four were short-circuits on the secondaries of customers, and were severe enough to throw out the secondary breaker, the sub-station breaker and the power-house breaker all at once; the other two were from unknown causes. The total time the power has been off because of these troubles is thirty-two minutes.

Exhibitors at the St. Louis Exposition will have to pay $10 per horse-power per month for power, the charge in each case to be based on the motor capacity installed by the exhibitor, and irrespective of the amount used.

A THREE-WIRE FIVE-HUNDRED-VOLT LIGHTING SYSTEM.[1]

BY WALTER I. BARNES.

"Those who know best what is required to meet all issues and to establish a business, including the complex factors and conditions assembled in undertakings for central station work, are those who have invested their money in it and are employed daily in its management."

With slight changes in form this precept might well be applied to any commercial or financial enterprise; as originally voiced, however, its particular and peculiar application was the central station for supply of electrical energy. The speaker of that occasion surely did not have in mind the details of any possible future development in the properties under his management, but he certainly did realize that there were many issues to be met and that the complex factors and conditions were frequent, and his evident purpose was to rid the situation of its complexities and to establish a business on an efficient and well disciplined organization. The date of this wholesome utterance was August 19, 1890, at a meeting of this association, the speaker being the then president of the association, Mr. Marsden J. Perry, who was then and is now the general manager of the Narragansett Electric Lighting Company, Providence, R. I.

At that time, other than for the companies operating under the Edison organization, with perhaps a few exceptions, there was but one path to follow where multiple distribution of electrical energy was concerned, and that was the two-wire system, using either the direct or alternating current.

The two-wire system, for obvious reasons was almost entirely neglected except for motor systems operated at 500 volts direct current, and the field was practically given up to alternating-current distribution.

The manufacturers of electrical apparatus fourteen or fifteen years ago were not unwilling to dispose of their product, and the salesman most appreciated. if one may judge by results, was he who sold the greatest number of small generators and diminutive transformers. In one case, at least, the argument was used by the representative of a well-known manufacturer that by using generators of low capacity and transformers or small units, the chances of a general interruption of service were materially lessened, as one burnt-out generator or transformer would affect but a small part of the system. Whether or not the argument above noted was generally used, the result seems to have been accomplished, for it was not at all uncommon in the early part of the last decade to find alternating-current systems in large cities where the largest single transformer did not exceed three kilowatts capacity, and the fashion seemed to demand even smaller units.

The incandescent lamp of the times was on the borderland of voltage. Some of the manufacturers declared boldly for the 100-volt type, yet acknowledged the better efficiency of the fifty-volt standard of preceding years. With two lamp voltages in the market, the central station manager alive to the situation demanded transformers that were equally well adapted for use with the lamps of either voltage, the result being the three-wire transformer, which made possible a considerable saving in copper when three-wire, fifty-volt, secondary mains were considered, or when used with two-wire mains at 100 volts.

While the transformer engineer was devoting his energy to lessening the fixed losses and improving the regulation of the transformers, the lamp manufacturer was bending every effort to produce a lamp of better economy than heretofore, which would give a fair and reasonable life when subjected to the conditions of transformer regulation then existing. The result, although by no means perfect, was highly satisfactory in comparison with past records, so that in 1896 to 1898 the 100-volt type was the equal, if not the superior, of the fifty-volt lamps of two years previous. With this fact well established, the natural enquiry of the interested middleman between manufacturer and consumer was, if the 100 and 110-volt lamp so soon supplanted the fifty and fifty-five-volt type, why may we not have 200-volt or even 220-volt, and possibly 250-volt lamps, and still further decrease the copper investment?

In 1897 the commercial 220-volt incandescent lamp was yet in the future; in 1899 the 250-volt lamp was in increasing demand, and the first American installation of any magnitude using the so-called high-voltage lamp was made under the engineering advice of Mr. Bion J. Arnold, in St. Louis, Mo., and is fully described in a preliminary paper at the Omaha meeting of the American Institute of Electrical Engineers in June, 1898, although the system was not in commercial operation until some months later. Ow-

[1] Read before the National Electric Light Association at its twenty seventh convention, held at Boston, Mass., May 24, 25, 26 and 27, 1904.

ing to certain legal obstructions it was inadvisable for the St. Louis system to be installed as a pure three-wire arrangement, and it was left for the Narragansett Electric Lighting Company to be first in the field using a direct-current, three-wire feeder-and-main system with grounded neutral.

The original request of the general manager called for a report on a five-wire system using 125-volt lamps and a three-wire system using 250-volt lamps, and a joint report was presented by Mr. William C. Woodward, the electrical engineer of the Narragansett Electric Lighting Company, and Mr. Bion J. Arnold, in May, 1899.

The immediate decision of the manager was in favor of the three-wire system. With the 250-volt lamp as a factor in the situation, the alternating-current transformer was no longer a necessary part of the system, for, wherever a 500-volt, two-wire system could be operated to advantage, it was at once possible to modify the arrangement so as to allow of the use of a three-wire, 250-500-volt system.

In 1899 the Narragansett Electric Lighting Company had a connected load of 9,000 kilowatts, of which 4,900 kilowatts was in alternating-current multiple distribution, 2,700 kilowatts in direct-current, 500-volt motors, 400 kilowatts in series commercial arc lamps, and 1,000 kilowatts in series arc lamps on city contracts. The electrical generating equipment consisted of three 500-kilowatt, alternating-current, sixty-cycle generators; three 500-kilowatt, direct-current, 500-volt generators; sixteen Thomson-Houston series generators, fifty-light capacity each, and eighteen Fort Wayne series generators, 125-light capacity each.

A city ordinance relating to overhead wires required that all overhead construction of the Narragansett Electric Lighting Company within the close fire district of the city should be removed within three years from the passage of the act. This necessitated the removal of 600 poles and about 160 miles of wire in any event and as the company, for the benefit of the service, proposed to extend the district prescribed by the ordinance, the amount of territory was voluntarily increased about 100 per cent.

In general, the proposed reconstruction provided for, first, the construction of a complete underground system; second, an installation of a storage battery; third, the discontinuance of the alternating-current system in the close fire district and some adjacent territory; fourth, the discontinuance of the commercial series generators; fifth, the removal of the poles and wires as required by the ordinance.

The construction of the conduit system was begun in October, 1898, and continued until December, 1901, during which time forty-nine miles of streets were opened and 1,700,000 feet of ducts were laid. Of this amount about 1,000,000 feet are single duct and 700,000 feet, multiple duct. There were built about 850 manholes of an average size of six feet square and seven feet deep. The ducts that were used in the underground system were laid on a three-inch bed of concrete, which was spread on a spruce-board bottom; the side walls beyond the ducts were of concrete three inches thick and well rammed between the side boarding and the ducts. Over the ducts was a three-inch layer of concrete, above which was placed a protective layer of creosoted plank an inch and a half thick. After laying, the ducts were all rodded and cleaned, ready for drawing in of cable.

Owing to the peculiar location of the streets along the river front, the conduit system was often constructed below tide level, and it became necessary to waterproof the system of conduits and manholes where the same were close to the water front. This was accomplished by building twelve-inch side walls on the concrete bottom of the trench, and covering the side walls and concrete with several layers of tar paper laid in hot asphalt. The waterproofing of the manholes was accomplished in a similar manner, and the results indicate that such a method is perfectly satisfactory.

Into this system of ducts there was drawn about 2,000,000 feet of cable, varying in size from No. 14 B. & S. gauge, used as potental wires, to cables having an area of 1,000,000 circular mils, used as tie lines between generating and battery stations. Rubber-covered cable only was used, the insulation being Okonite, varying in thickness from five-thirty-seconds to nine-thirty-seconds of an inch, according to purpose for which it was intended. The five-thirty-seconds-inch insulation was used in the three-wire system. For the alternating-current, 2,200-volt system and in the constant-current, 6,050-volt system, the insulation was seven-thirty-seconds, and in the 11,000-volt transmission circuits the thickness of insulation was nine-thirty-seconds of an inch. It it worthy of note that in five years of continuous operation not a single fault has developed in the cable or conduit system.

In the direct-current system there was used about 1,100,000 feet of cable. The main conductors have an area of 200,000 and 300,000 circular mils, according to the district in which they are situated. The feeders vary in area from 200,000 circular mils to 500,000 circular mils, according to length and load.

There are thirty-three feeder points in the direct-current system, and the connected load at present is about 9,000 kilowatts, of which 4,000 kilowatts consists of stationary motors varying in capacity from 0.25 kilowatt to seventy-five kilowatts. The remainder of the load consists of 80,300 incandescent lamps and 1,280 arc lamps. The incandescent lamps average 3.3 watts per candle-power, and have a useful candle-hour area of not less than 4,000 hours, assuming the smashing point to be eighty per cent of the initial candle-power.

It is quite interesting to recall that in 1899 the average watts per candle varied from 3.8 to four watts, and at that time the candle-hour area did not exceed 2,900 hours.

The arc lamps in use at present are of the twin-carbon, enclosed type, and operate in multiple on 250-volt circuits—that is, two arcs in a single inner globe—the current averaging 2.3 amperes, the energy per lamp averaging about 575 watts. This lamp has proved quite satisfactory, and is much to be preferred to the single-carbon lamp, in which the volts at the arc are about 160.

For the purpose of producing the best possible regulation of the system and also to tide over the peak load, a storage battery was installed at a substation about 2,400 feet from the generating station, in a location which in time will be fairly in the centre of the distributing system.

The battery consists of 296 cells of forty-three plates each, the eight-hour discharge rate being 840 amperes.

The cells are mounted on an insulating system, which has served to annihilate the various troubles often found in battery insulation. A double tier of porcelain insulators is used; the first tier is mounted on four brick piers, which are capped with a hard-pressed tile thoroughly impregnated by boiling in paraffin; triple-petticoated porcelain insulators are then placed on the tile. Longitudinally with the cell and resting on the four insulators are placed two hard-pine sticks, four by four and three-quarters inches, well painted with an acid-proof paint. On each of these hard-pine sticks are placed three tiles boiled in paraffin, and resting on these tiles is a second tier of porcelain insulators, which, in turn, support the battery tanks. The distance from the floor to the bottom of the tank is 20.75 inches. The floor under each cell is pitched from a point under middle of cell to the aisle between the cells at an angle of about twenty degrees. This allows any surface water or dripping from tank to drain off rapidly.

Frequent washings of the floor immediately under the tank and systematic cleaning of the insulators that may be conveniently and safely reached have served to produce the best results in practice, the leakage to earth being entirely eliminated.

The battery is seldom discharged in regular service to exceed the three-hour rate, and then only for a period of about an hour. The load on the system is so evenly balanced that seldom does the unbalanced condition exceed three per cent of the load appearing, and the neutral conductor is of ample capacity, even should the unbalancing greatly exceed the figure given. In order, however, that the battery may be always in balance as near as possible, a balancer generator is to be installed.

While the conduit system and the stor-

age battery were being installed, active preparations were being made whereby existing installations on the alternating-current, two-wire system might be readily transferred to the direct-current, three-wire system.

As the 250-500-volt, three-wire system that it was proposed to install was a radical departure from all standards then existing, every precaution was taken to obtain the best and safest results. It was decided to rewire most of the older installations, and although in many instances the wiring in customers' premises called for but slight modification, yet there were other cases where the entire wiring equipment was replaced.

Certain types of fittings were adopted as standards, so that the installations might be uniform throughout the entire territory. The Edison type of fibre-lined socket with a mica disc under centre contact was adopted as a standard socket. Enclosed fuses of plug and cartridge type were used to replace open-link forms of by-gone days. Modern switches took the place of older patterns, and iron or steel pipe was generally used to replace the wooden moulding of previous years.

There was naturally found a great saving in the amount of copper used in the new system, which was of great benefit to the consumer. In rewiring some old installations it was not unusual to find out two or perhaps three No. 0000 wires in each side of the mains, run in a heavy moulding from transformer to centre of distribution, the installation having been made in the old days of 4.5-watt, fifty-volt lamps. These conditions were in marked contrast to the small iron pipe run from manhole to centre of distribution, and the three No. 10 wires that were drawn into same and supplied an equal amount of energy as in the case just mentioned.

Aside from the very material view of the investment saving under the new arrangement, there is the æsthetic viewpoint, which is much better satisfied in the improved construction made possible by the feature of the present system, which tend to, and do, produce a neater, safer and more compact installation.

The several sections of the city that were included in the changes were served with about 50,000 incandescent lamps, 1,000 arc lamps and 2,000 kilowatts in stationary motors, and these installations were reconstructed to comply with the requirements of the new system; the change from aerial to underground supply, and from alternating-current to direct-current service, was made without any interference with the customer.

The commercial series arc lamps being replaced by multiple arc lamps of the new type, the series generators were released from service at the central station.

The arc lamp situation was at first rather perplexing, as none of the larger manufacturers was inclined to provide such a lamp as was demanded. A local manufacturer finally produced a lamp that was the forerunner of those which are now generally used.

All motors of the direct-current type are connected to the outside or 500-volt wires, and although these motors operate devices that are subject to wide and sudden changes in load, yet the lighting service is in no way affected by such disturbances of load condition.

In a central station already operating a two-wire, 500-volt motor system, the addition of a third wire is all that is necessary to obtain an efficient and a flexible wiring system for lighting purposes. The fact, too, that the same generating apparatus may be used for both motor and lighting service is no small factor in the situation, the natural motor load being a day load, while the lighting load, generally extending well into the night, serves to produce a very satisfactory load curve, particularly if a properly proportioned storage battery forms part of the equipment.

The direct-current load curve of the Narragansett Electric Lighting Company is of such a character that during seventeen hours out of the twenty-four a 2,000-kilowatt unit could be operated under advantageous conditions.

Owing to the hurried preparation of this paper, the several subjects have not been treated in as connected an order as the author had originally intended, but before closing a reference may well be made to the personal and property hazard incident to a three-wire, 500-volt system.

The management of the Narragansett Electric Lighting Company, realizing that the public was to be given every consideration in the matter of protection, laid the plan of the proposed system before recognized authorities on fire hazards, and received their approval for the undertaking of the work.

The personal risk was also fully discussed, and it was determined that there was no objection to the installation of a system such as described in the foregoing article when accident to person was considered. An additional and convincing endorsement of the above is found in the fact that during five years of operation there has not been a single fire loss or personal injury for which this system was responsible.

The author personally favors the general use of neutral connection, which is continuous from source of supply to point of use, and is thoroughly grounded at every possible point inside the customers' premises, and certainly in the network of mains and feeders in the streets. The use of single-pole switches on the positive and negative sides of the system is a sufficient means of opening any branch circuit. A typical installation embodying the ideas just noted is found in the wiring system in the Union Trust Company building at Providence. In this building the neutral consists of a continuous copper conductor from street mains to top floor of building, the structure being twelve stories high. At each floor there is a centre of distribution for that floor, these centres being in turn supplied by one of the four-feeder circuits from main distributing board in basement—each feeder circuit supplying three floors. All tap circuits are single-wire, the pipe system and frame of building being used as a neutral conductor. The ends of the pipe system at centres of distribution are bonded together and to the common copper neutral riser. Single-pole switches and cartridge fuses are used in the branch circuits.

In connection with this installation it may be noted that the space required for the positive and negative feeders in the wire shaft is only three by nine inches, each feeder being installed in an iron pipe. This space, compared with what would be required if a 110-volt system was used, would give some idea of the practical economy in operating at the higher voltage.

The installation just cited is but one instance of the use of the intentionally grounded neutral—the whole system being planned on similar lines, and in some instances, where found advisable, bare copper is used in the neutral branches.

All previous references in this paper have applied to the direct-current system, but the Narragansett Electric Lighting Company has proved to its satisfaction that the same general methods may as well be used on alternating-current systems. The direct-current system having been well established on the lines indicated in this paper, changes are now in progress which in a few months will place all alternating-current service on a three-wire system of 250-500-volt secondary mains with grounded neutral. Several sections of the city outside the direct-current district have already been remodeled with results that confirm the calculations. When the changes shall have been firmly accomplished the entire incandescent lamp business of the company, amounting to about 185,000 lamps on a sixteen-candle-power basis, will be operated at 250 volts, and all motors, both direct-current and alternating-current, will be of standard 500-volt types.

There will, without doubt, be many refinements in the details of the system as the work progresses, but, generally speaking, the statement of 1890 has been fulfilled, as apparently the present system is what is required to meet all issues, including the complex factors and conditions of central station work.

A Damping Device.

A new device for damping oscillations has been devised by MM. Favé and Carpentier, which consists of an arrangement of very thin glass fibres fixed radially and fastened to the oscillating needle. The centre of this system is in the axis of oscillation, and the fibres lie in a horizontal plane. The nature of the surface of these fibres is apparently of small consequence, since other material than glass-hair, for instance—may be used. To obtain a strong damping effect, a large number of these fibres is necessary, but it is essential that they be kept some distance apart, as otherwise the hair is caught in the bunch of fibres and carried around with it.

DATA AND TESTS ON A 10,000-CYCLE-PER-SECOND ALTERNATOR.[1]

BY B. G. LAMME.

In the early part of 1902, M. Leblanc, the eminent French engineer, was in this country, and spent considerable time at the Westinghouse Electric and Manufacturing Company's works at East Pittsburg. M. Leblanc was very much interested in certain special telephone work, and in connection with such work he desired for experimentation a current of high frequency. He took up with the writer the question of building a successful alternator for generating current at frequencies between 5,000 and 10,000 cycles per second. He was informed that the machine would necessarily be of very special construction, but that it was not an impossible machine. Later he took up the matter with Mr. Westinghouse, who, upon receiving satisfactory assurance that such a machine was possible, advised that the generator be built. A preliminary description of the general design was given M. Leblanc before he returned to Paris. He was somewhat surprised at certain of the features proposed, especially at the fact that an iron-cored armature was considered feasible for a frequency of 10,000 cycles per second.

The machine was designed and built on practically the lines of the preliminary description furnished M. Leblanc. The frequency being so abnormal, the writer believes that many features in the machine, with the results obtained, will be of scientific interest, and therefore the data of the machine and the tests obtained are presented herewith.

The starting point in this machine was the sheet steel to be used in the armature. No direct data were at hand showing losses in sheet steel at such high frequencies, nor was there at hand any suitable apparatus for determining such losses. As preliminary data, tests at frequencies up to about 140 cycles per second were used, and results plotted in the form of curves; these results were plotted for different thicknesses of sheet steel. Also, tests were obtained showing the relative losses due to eddy currents and hysteresis, and these were plotted, taking into account the thickness of the sheets. These data were not consistent throughout; but the general shape of the curves was indicated, and in this way the probable loss at the frequency of 10,000 cycles per second was estimated for the thinnest sheet steel which could be obtained. The steel finally obtained for this machine was in the form of a ribbon about two inches wide, and about 0.003 inch thick, which was very much thinner than any steel used in commercial dynamos or transformers which varies from 0.125 to 0.0280 inch. Therefore the machine had to be designed with the intention of using this narrow ribbon of steel for the armature segments.

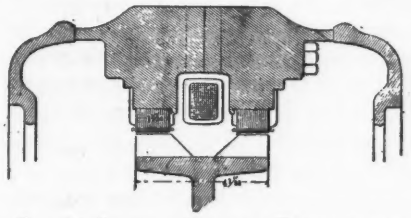


FIG. 1.—SHOWING GENERAL CONSTRUCTION OF ARMATURE.

A second consideration of great importance in the construction of such a machine is the number of poles permissible for good mechanical construction. For instance, at 3,000 revolutions—which was adopted as normal speed—the number of poles required is 400 for 10,000 cycles per second. The frequency, expressed in terms of alternations per minute, multiplied by the pole-pitch in inches, gives the peripheral speed in inches. At 1,200,000 alternations per minute (or 10,000 cycles per second) and a pole-pitch of 0.25 inch, for example, the peripheral speed of the field will be 25,000 feet per minute. It was therefore evident that either a pole construction should be adopted which would stand this high peripheral speed, or the pole-pitch should be less than 0.25 inch. It was finally decided than an inductor type of alternator would be the most convenient construction for this high frequency; with the inductor type alternate poles could be omitted, thus allowing 200-pole projections instead of 400. The field winding could also be made stationary instead of rotating, which is important for such a high speed. This construction required a somewhat larger machine for a given output than if the usual rotating type of machine were adopted; but in a machine of this type, where everything was special, the weight of material was of comparatively little importance, and no attempts were made to cut the weight or cost of the machine down to the lowest possible limits.

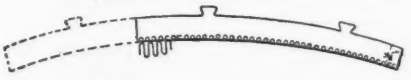


FIG. 2.—SHOWING DESIGN OF LAMINATIONS.

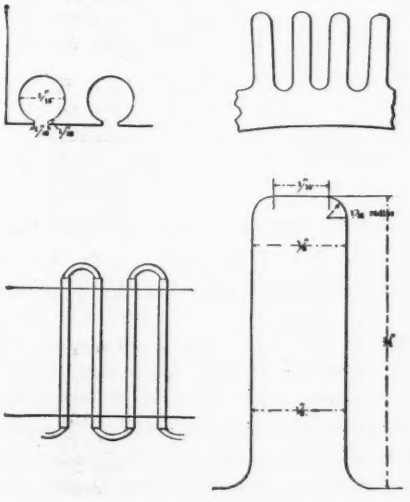


FIG. 3.—SHOWING SLOT IN ARMATURE RING.
FIG. 4.—MANNER OF CONNECTING THE WINDING.
FIG. 5.—SHOWING THE SLOTTING ON THE PERIPHERY OF THE RING.
FIG. 6.—SHOWING THE GENERAL DIMENSIONS OF A POLE.

The following covers a general description of the electrical and magnetic features of the machine:

Armature—The armature was built up in two laminated rings dovetailed into a cast-iron yoke, as indicated in Fig. 1. The laminations were made in the form of segments dovetailed to the cast-iron yoke (Fig. 2). Special care was taken that the laminations made good contact with the cast-iron yoke, as the magnetic circuit is completed through the yoke.

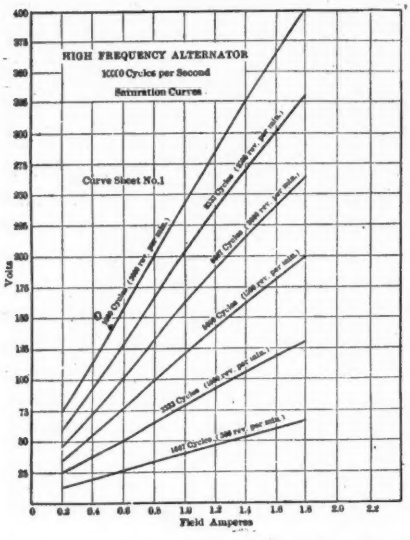
The armature sheet steel consisted of plates of 0.003 inch thickness. The sheet-steel was not annealed after being received from the manufacturer; it was so thin that to attempt annealing was considered inadvisable. To avoid eddy currents between plates each segment was coated with a thin paint of good insulating quality. This painting was a feature requiring considerable care and investigation, as it was necessary to obtain a paint or varnish which was very thin, and which would adhere properly to the unannealed laminations. These laminations had a bright polished appearance quite different from that of ordinary steel. They were so thin that the ordinary paint or varnish used on sheet steel made a relatively thick coating, possibly almost as thick as the plates themselves. A very thin varnish was finally obtained which gave a much thinner coating than the plate itself, so that a relatively small part of the armature space was taken up by the insulation between plates.

Each armature ring or crown has 400 slots. Each slot is circular and 0.0625 inch diameter (Fig. 3). There is 0.03125 inch opening at the top of the slot into the air-gap, and the thickness of the over-

[1] A paper presented at the 187th meeting of the American Institute of Electrical Engineers, New York, May 17-18, 1904.

hanging tip at the thinnest point is 0.03125 inch.

The armature winding consists of No. 22 wire, B. & S. gauge, and there is one wire per slot. The entire winding is con-



SHOWING SATURATION CURVES FOR VARIOUS SPEEDS.

nected in series (Fig. 4). The measured resistance of the winding is 1.84 ohms at twenty-five degrees centigrade.

After the sheet steel was built up in the frame, it was ground out carefully. The laminations were then removed, all burred edges taken off and the laminations again built up in the frame. The object of this was to remove all chances of eddy currents between the plates due to any filing or grinding. The finished bore of the armature is 25.0625 inches.

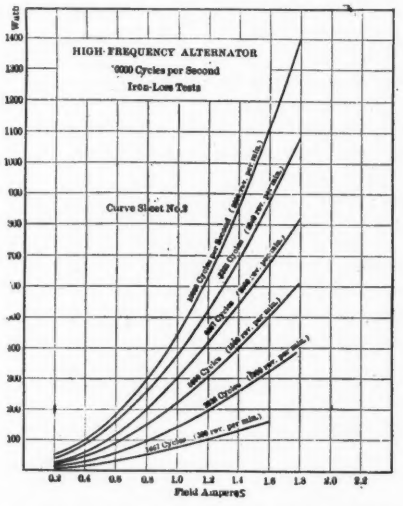
Field or Inductor—This was made of a forged-steel disc twenty-five inches in diameter turned into the proper shape, and the poles were formed on the outside by slotting the periphery of the ring. The general construction is indicated in Figs. 1 and 5. The poles were 0.125 inch wide and about 0.75 inch long radially and were round at the pole-face. Fig. 6 shows the general dimensions of a pole.

The field winding consisted of No. 21 wire, B. & S. gauge. There were 600 turns total arranged in thirty layers of twenty turns per layer. The field coil after being wound was attached to a light brass supporting ring. The general arrangement of the field or inductor, armature yoke and bearings is as indicated in Fig. 1. The measured resistance of the field winding is 53.8 ohms at twenty-five degrees centigrade.

Tests—The machine was designed primarily for only a small output, but was operated on temporary test up to two kilowatts. A series of curves was taken at 500, 1,000, 1,500, 2,000, 2,500 and 3,000 revolutions giving frequencies from 1,677 to 10,000 per second. At each of the above speeds, saturation curves, iron losses and short-circuit tests were made. Friction and windage were also measured at each speed.

On account of the high frequency, the machine was worked at a very low induction; consequently there is an extremely wide range in pressure, the normal operating pressure being taken at approximately 150 volts.

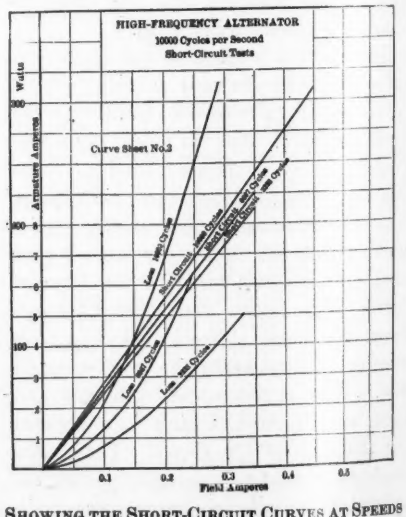
On curve sheet No. 1, the saturation curves for the various speeds are given. These curves check fairly well, the pressure being practically proportional to the speed with a given field charge. This is to be expected at the lower speeds, but it was considered possible that at 3,000 revolutions the air-gap might be slightly lessened, due to the expansion of the rotor under centrifugal action; and it was also



SHOWING IRON LOSSES AT VARIOUS SPEEDS.

thought that eddy-current loss due to the high frequency might affect the distribution of magnetism at the armature face; but the armature iron losses were comparatively small, and there appeared to be no such effect. Also there appears to be no effect due to expansion at high speed. The air-gap specified for this machine is 0.03125 inch on each side or 0.0625 inch total gap. A very small variation in the diameter of the inductor or the bore of the armature would make a relatively large per cent in the effective air-gap. Therefore no reliable calculations can be made on the saturation curves of this machine based upon the specified air-gap.

Curve sheet No. 2 shows the iron losses at various speeds from 500 to 3,000 revolutions per minute—1,667 to 10,000 cycles per second. These losses are plotted in terms of watts for a given exciting current. These curves show a rather unexpected condition as regards the losses. According to the original data showing the relative loss due to eddy currents and hysteresis, the eddy-current loss even with these thin plates should have been much higher than the hysteresis loss, but these iron-loss curves show losses with a given field charge almost proportional to the frequency, which is the ratio that the hysteresis loss alone should show. As the eddy-current loss varies as the square of the frequency, the writer expected this to be a large element in the total iron loss, especially at the higher inductions. The six curves shown on this test-sheet are fairly consistent with each other, but it should be remembered that in making measurements of such abnormal apparatus little discrepancies in the curves could easily creep in. For instance, in the saturation curve a series of experiments were first made to find whether usual types of voltmeters were satisfactory, and a number of different methods for checking these readings were used. In determining the iron losses in curve sheet No. 2, the machine was driven by a small motor and the losses measured with different field charges. Under most conditions of test the iron loss was a small element of the total loss, and therefore slight variations in the friction loss would apparently show large variations in the iron losses. Also the flywheel capacity of the rotating part of the alternator was comparatively high. Therefore, if there are any variations in the circuits supplying the driving motor, there would tend to be considerable fluc-

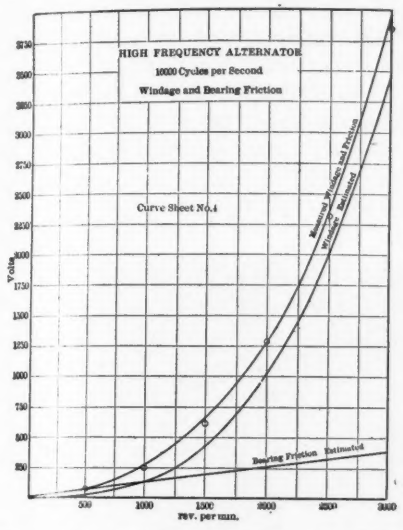


SHOWING THE SHORT-CIRCUIT CURVES AT SPEEDS OF 1,000, 2,000 AND 3,000 R. P. M.

tuation in the power supplied. Considering all the conditions of test, the curves appear to be remarkably consistent.

Curve sheet No. 3 shows the short-cir-

cuit curves at speeds of 1,000, 2,000 and 3,000 revolutions per minute, or frequencies of 3,333, 6,667 and 10,000 cycles per second, respectively. It should be noted that at a given frequency the short-circuit current is proportional to the field current over the entire range measured, but that



SHOWING THE MEASURED WINDAGE AND FRICTION LOSSES PLOTTED AT SPEEDS FROM 500 TO 3,000 REVOLUTIONS PER MINUTE.

the short-circuit current is not the same for the same field current at the various frequencies. According to these curves the current on short-circuit increases somewhat with the given field charge as the frequency is increased.

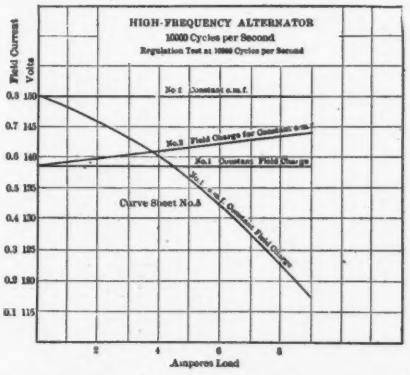
Curve sheet No. 4 shows the measured windage and friction losses plotted at speeds from 500 to 3,000 revolutions per minute. This curve indicates clearly that the windage is the principal friction loss at the higher speeds. The writer had added two curves, one showing the estimated bearing friction loss, and the other the estimated windage, based upon the assumption that the bearing friction varies directly as the revolutions and the windage loss with the third power of the revolutions. The small circles lying close to the measured loss curve show the sum of these estimated losses, and the agreement with the measured loss is fairly close over the entire range.

Curve sheet No. 5 shows regulation tests made at 150 volts. The power-factor of the load on this test was not determined, as it was extremely difficult to make accurate measurements. The load consisted of incandescent lamps and the wiring from the machine to the lamps was non-inductive for the usual frequencies; but at the abnormal frequency of 10,000 cycles per second it is more difficult to obtain a true non-inductive load with ordinary apparatus. The tested regulation indicates that the load was practically non-inductive.

In first undertaking tests on this machine there was considerable difficulty in measuring the pressures. It was found that at a frequency of 10,000 cycles per second the Weston voltmeter did not work satisfactorily. Practically the same deflection was obtained on the high and low scales of a 60 to 120-volt Weston alternating-current direct-current voltmeter with the same pressure.

Very good results were obtained by the use of a form of static voltmeter devised by Mr. Miles Walker. This voltmeter is of the same form as the static wattmeter described by Mr. Walker before the American Institute of Electrical Engineers, May, 1902.[1] Tests were also made with the Cardew hot-wire voltmeter with the high frequencies, and the results checked very satisfactorily with the static voltmeter.

For measuring the current a current dynamometer was used which had wood upright supports and a celluloid dial. The only metal parts outside of the copper coils were brass screws. It was found that the current dynamometer is not affected by frequency, unless there are adjacent metal parts in which eddy currents can be generated which react upon the moving element. The dynamometer used had but a few turns in order to reduce the pressure drop across it. This dynamometer was checked very carefully at different frequencies and apparently gave similar results for any frequency between 25 and 10,000 cycles.



SHOWING REGULATION TESTS MADE AT 150 VOLTS.

Several temperature tests were made on this machine. The heaviest load on any test was 13.3 amperes at 150 volts, or two-kilowatt output. This test was of two hours' duration, and at the end the armature iron showed a rise of sixteen degrees centigrade; the armature copper twenty-one degrees centigrade by resistance, and the field copper 17.3 degrees centigrade. Air temperature nineteen degrees centigrade. The machine showed a relatively small increase in temperature at this load over the temperature rise with one-third this load. This was probably due to the fact that the windage loss was so much higher than the other losses of the machine that the temperature was but little affected by the small additional loss with increase in load.

Attempts were made to utilize the current from this machine for various experiments, but difficulty was at once found in transforming it. At this high frequency no suitable iron-cored transformer was available. Transformers with open magnetic circuits were tried and operated better than those with iron cores, but were still rather unsatisfactory. It was decided that nothing could be done in this line without building special transformers.

Among the few experiments made was that of forming an arc with current at this high frequency. This arc appeared to be like an ordinary arc so far as the light was concerned, but had a very high-pitched note corresponding to the high frequency. This note was very distressing to the ears.

This machine is in reality of the nature of a piece of laboratory apparatus; and at present it has no commercial value. It was designed primarily for scientific investigation, and appears to be a very good machine for that purpose.

[1] Transactions of the American Institute of Electrical Engineers, vol. xix, p. 1,035.

An Automatic Gas Pump.

At a meeting of the Physical Society of London, Mr. C. E. S. Phillips exhibited and explained an automatic gas pump for exhausting Rœntgen-rays and other tubes. This pump has been devised with a view to providing a comparatively portable machine, suitable for special laboratory work, or for researches requiring prolonged pumping. It consists of three distinct parts: a small motor-driven mechanical pump, a four-way control valve and a modified Toepler apparatus, by which the final vacuum is obtained. The glasswork is easily removed for cleaning and repairs. The height of the complete apparatus is eighteen inches. Experiments showed that it is fairly rapid in its action. A Rœntgen-ray bulb of 200 cubic centimetres capacity was exhausted in half an hour.

Massachusetts Institute of Technology.

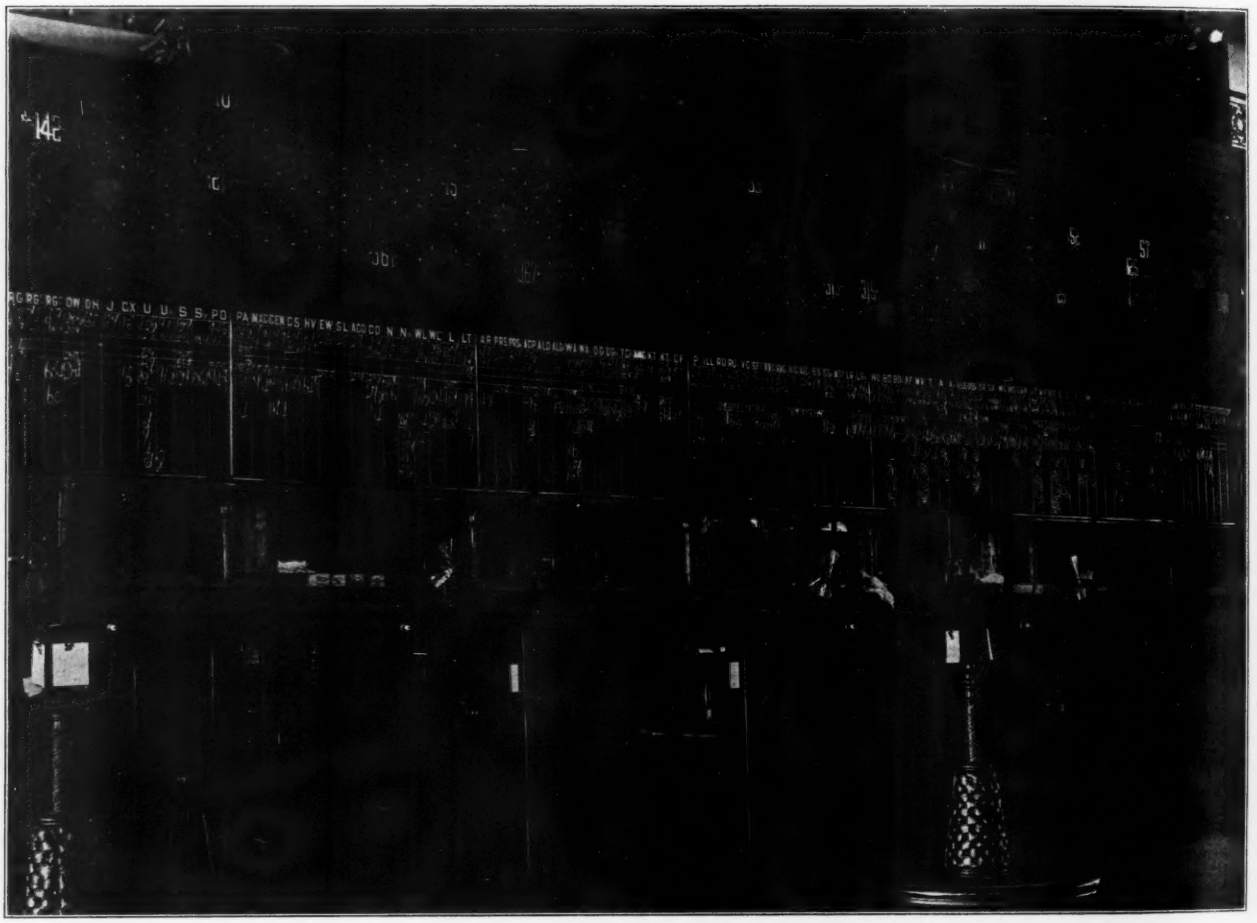
The Massachusetts Institute of Technology, Boston, Mass., has issued a bulletin describing the courses offered in mining engineering and metallurgy. The institue is well equipped for giving instruction in these branches, the bulletin can be had by addressing the secretary, Mr. Harry W. Tyler, 491 Boylston street, Boston, Mass.

The New Signaling System at the Consolidated Exchange, New York City.

A Lamp Annunciator System Does Away with the Annunciator Drops.

THE Consolidated Exchange, New York city, has adopted a new plan of signaling, which supersedes the long-established drop annunciator system. For a long time in New York city, if a broker who happened to be on the floor was wanted at the telephone or at one of the entrances to the building, it was necessary to have a boy go about on the floor calling his name until he could be found, and the message delivered to him. An improvement over this method was effected when an arrangement was adopted exposing a shutter upon which a specified number appeared, directing the attention of the broker to the call. This method, however, has proved costly in maintenance, and also was productive of considerable noise when the drops were worked.

Mr. Frank E. Kinsman, treasurer of the Kinsman Electric and Railway Supply Company, New York city, was called upon to devise a new signaling system, and he conceived the idea of perfecting one which would be absolutely noiseless and would have such simple characteristics as would render maintenance charges very slight.



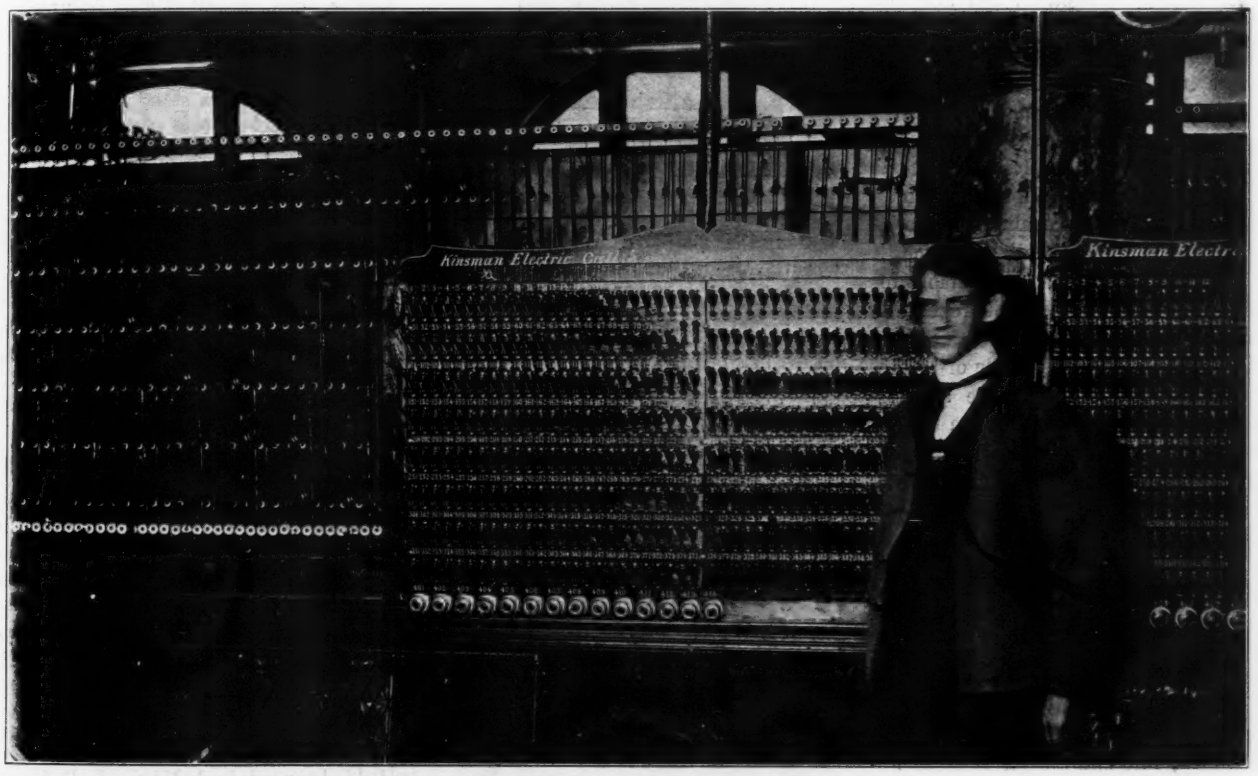
THE NEW LAMP SIGNAL BOARD AT THE CONSOLIDATED STOCK EXCHANGE, NEW YORK CITY, SHOWING TELEPHONE BOOTHS UNDER STOCK QUOTATION BOARD.

The accompanying illustration shows the method in which the signal boxes have been installed. Upon an angle-iron framework there have been placed 414 eight-inch square sheet-iron boxes. Within these boxes, mounted upon porcelain pedestals which are screwed with an asbestos washer to the bottom of the box, are three eight-candle-power 118-volt lamps. Each of these lamps has a distinctive color. There is a green lamp, which announces a call for a broker at the Broadway entrance; a red lamp, announcing a call for the New street entrance, and a lavendar lamp, which announces a telephone call. There is a switchboard located immediately behind the signal board, upon which are placed 414 switches. The attendants at each of the entrances are connected by telephones with the operator at this switchboard. When a broker is called for, his number is communicated to the switchboard attendant, who flashes the signal necessary. If a broker is wanted at the telephone, the attendant is called by the ringing of the bell, and, upon investigation, finds the proper instrument and gives the signal with a push-button switch. The broker answers the call, and, when through, destroys the signal by throwing off the switch above the telephone instrument.

The front of the box is a ground-glass square, and the letters are about six inches high, each stroke being about half an inch wide.

The wiring arrangement has been worked up with a great degree of ingenuity, and is very creditable to Mr. W. T. Haines, who did this part of the work for Mr. Kinsman. An Edison three-wire service is used, and it is imperative that the circuits be perfectly balanced. From the main terminals, which are at 118 volts, with a rated load of 300 amperes, the current is reduced by multiple connections through seventy-five-ampere fuses, making two 150-ampere three-wire circuits. From this point cross-connections are made through Edison cap fuses onto a distributing fuse-board, so that the current is reduced to five amperes. The neutral current is led from the fuse-board, and divides itself equally across each half of the main switchboard, one-half controlling the green lights, and the other half controlling the red lights. The negative and positive circuits are equally divided across the signal board. The neutral current is carried to each telephone signal, the same as to the switchboard, with the exception that, instead of a bus-bar controlling twenty switches, the neutral wire itself is used as a bus. As there are three lights in a box, each circuit combination consists of seven boxes, or twenty-one lights. There are sixty-nine boxes in each of six rows. In order to get in seven boxes, or twenty-one lights, in a combination, the first box on the second row is wired, and this is jumped across to the six in the first row. In turn, the first and second boxes in the third row are wired and jumped across to the five boxes in the second row. The first, second and third boxes in the fourth row are wired and jumped across to the remaining four boxes in the third row, and so on throughout the board.

Everything has been done in the most substantial manner. The wiring has been bunched into cables which are securely fastened to rigid supports. Every connection has been soldered and taped, and apparently there is no opportunity for accident. The system is working perfectly and giving great satisfaction to the members of the exchange.



THE BACK OF THE LAMP SIGNAL BOARD AT THE CONSOLIDATED EXCHANGE, NEW YORK CITY, SHOWING WIRING SCHEME, AND SWITCHBOARD FOR PUTTING UP THE SIGNALS.

Electrical Nomenclature.

At a recent meeting of the Socété Internationale des Électriciens, a discussion took place on electrical nomenclature. M. Lauriol was opposed to the expression "imaginary current," which had been given to one of the components of an alternating current. He preferred the terms "active current" and "inactive current" for these two components. The two terms for the corresponding power are designated as "true power" and "fictive power." He further suggests that the second be used as the practical unit of time. As a consequence of this, the joule becomes the practical unit of energy, thus avoiding the confusion which at present often arises between the term for power, "kilowatt," and for energy, "kilowatt-hour." The megajoule forms a good practical unit. M. Boucherot thought the most correct expressions for the two components of current were "the current in phase" and "the current in quadrature"; but as these expressions are not applicable to the power components, he uses the qualification "magnetizing current and power" and "active current and power." M. Tripier suggests the terms "supplementary current" for that which is incorrectly called "wattless," and "proportional current" for the other component which is proportional to the electromotive force. M. Arnoux prefers the expression "phase current and quadrature current." M. Janet thought that the terms "quadrature current" and "phase current" had some advantage, in that they held before the mind the idea of the phase relations of the circuit. M. Hospitalier suggests the terms "active current" and "reactive current" ("not inactive").—*La Revue Electrique (Paris), April 30.*

Fort Wayne Series Alternating System of Street Arc Lighting.

This system, in common with other alternating series arc lighting systems, consists of a combination of a constant-current regulator and a number of arc lamps connected in series. The Fort Wayne system includes the use of a "Wood" regulator, which is mechanically different from any others on the market, and form C "Wood" arc lamps specially designed for this service.

The automatic regulator consists of a ш-shaped laminated iron core and a reactance coil surrounding the centre leg of the iron core. The coil and core are hung on levers supported on knife edges in such manner that the coil and core counterbalance each other, and are both movable.

Through the lever system the coil forms a counterbalance to the heavy core and the levers are so arranged that of the total travel the coil moves over the greater portion of the distance. It is required to lift the core only through a short distance.

The regulator coil is connected in series with the arc lamp circuit to which it furnishes a constant current suitable for the arc lamps on the line. The regulation is automatic.

Any change in the resistance of the arc lamp circuit tends to produce a corresponding change in the current in the circuit, since the line voltage remains constant. But any change in the current changes the relative position of the core and coil, an increasing current bringing them closer together, a decreasing current allowing them to move further apart.

As the core enters the coil when they approach each other, due to an increase in current, the additional reactance caused by the magnetic condition thus created serves to counteract the decreasing resistance of the line and secures such an impedance that the current remains constant.

Any decrease in the load tends to increase the current and draws the coil and core together, thus increasing impedance in the circuit; while any increase in the load tends to decrease the current and allows the core and coil to separate, thus decreasing impedance in the circuit. The result is that the current is maintained at its normal value automatically. So perfect is the mechanical construction and electrical proportions of the regulator that the load may be reduced gradually from full load to no load until the regulator is directly across the line in short-circuit without causing any marked change in the current. The load may also be changed from full load to short-circuit, with but momentary current variation. This ensures perfect protection to the system against short-circuits due to failure of insulation of the outside lighting circuit.

When this regulator is intended for use on a small system of twenty-five lights or less the lighting system may be connected directly to the machine circuit without the use of transformers. When, however, it is necessary to install this series arc system on a machine supplying other circuits, a transformer is recommended. This transformer is connected between the machine and the series arc regulator circuit, ensuring perfect separation of its circuit from any others supplied from the same machine.

REGULATOR FOR ALTERNATING SERIES ARC SYSTEM.

REGULATOR FOR ALTERNATING SERIES ARC SYSTEM.

Transformers for this use are furnished with one to one ratio, or if higher voltages are required, with the proper ratio to obtain the desired voltage for the arc circuit.

It is frequently necessary in installing arc lighting systems to consider extensions of the system to meet the growth of the community.

The Fort Wayne series alternating system is designed to take care of extensions and at the same time operate efficiently with the initial load. This is done by installing a regulator large enough to meet the maximum future demands and a transformer furnishing proper voltage to economically operate the regulator with this partial initial load. This lower voltage is obtained from a series of transformer secondary taps by means of which the arc circuit voltage may be varied from fifty per cent of full voltage up to maximum secondary voltage in steps of such value that the circuit will always be working at approximately full-load efficiency. This method of transformation will allow a lighting plant to practically double its series arc lighting output without any increase in the regulating system or transformer, simply by changing the connections on the secondary taps of the transformer, and at all times ensures the highest economy and maximum power-factor in the regulator circuit.

Figs. 1 and 2 show the "Wood" regulator mounted on a stand for station installation. The knife edges are mounted on the casting supported on two A frames, between which the regulator is suspended. The joints in the levers furnish means for adjusting the regulator for the proper current.

To Welcome Foreign Electrical Engineers.

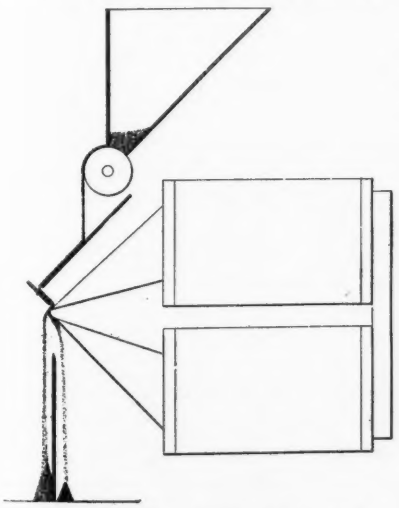
A meeting of the reception committee of the American Institute of Electrical Engineers, appointed to welcome the foreign electrical engineers attending the International Electrical Congress at St. Louis next September, was held at the office of the New York Edison Company on Friday of last week. The attendance was quite large, among those present being B. J. Arnold, president; J. W. Lieb, Jr., president-elect; Messrs. T. C. Martin, F. C. Bates, T. Beran, H. W. Blake, N. F. Brady, C. P. Bruch, F. B. Crocker, G. H. Guy, W. J. Hammer, H. McL. Harding, J. W. Howell, F. W. Jones, E. B. Katte, N. S. Keith, J. F. Kelly, H. W. Leonard, L. J. Magee, L. B. Marks, E. H. Mullin, F. A. Pattison, R. W. Pope, Charles W. Price, Calvin W. Rice, G. F. Sever, Samuel Sheldon, C. A. Terry, Calvert Townley, F. R. Upton, J. M. Wakeman and Arthur Williams.

Various subcommittees were appointed and a programme of entertainment planned. Fuller details will be announced as perfected later. The electrical interests of the city are cordially cooperating with the electrical engineers in extending courtesies to the visitors, and among the events proposed are boat rides on the Hudson, rides around New York city, a visit to the subway and visits to the big power stations. A banquet will be tendered the visitors on Monday evening, September 5, at the Waldorf-Astoria.

The International Electrical Congress opens at St. Louis September 12, and continues during the week.

Electrical Patents.

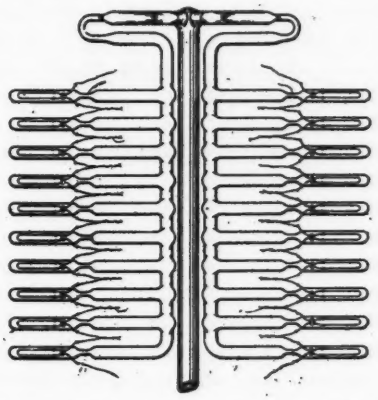
A magnetic separating apparatus has recently been patented by Mr. Thomas A. Edison, of Llewellyn Park, N. J., which is intended particularly for the separation from gangue and concentration of material which is only slightly magnetic, and the object is to provide an apparatus for the purpose of high efficiency, great capacity, and wherein the feed of the material to the magnetic devices and the separation of the magnetic and non-magnetic particles are effected by gravity and without the necessity of moving parts. In carrying out the invention, one or more sets of magnetic separators are employed, each being in the form of an ordinary double-coil electromagnet with extended tapering poles, one of which slightly overlaps the other to form a relatively narrow gap between them. To the upper face of the overlapping pole a continuous but thin stream of the particles moving at as slow rate as practicable is delivered, whereby the non-magnetic particles will be permitted to flow down the polar face and fall off therefrom at one side of the separating-board, while the magnetic particles will by the lines of magnetic force be attracted toward the other pole and will fall on the other side of the separating-board. Preferably a number of such separators are used, divided into two series, in the first of which the particles rejected by the



Magnetic Separating Apparatus.

first separating device will be subjected to the succeeding separators, whereby a very rough concentration will be secured; while in the second set the material concentrated by the first separator will be subjected to the succeeding separators to secure a concentrated product of high percentage.

Mr. Allen D. Whipple, of Chicago, Ill., is the inventor of an improvement in the manufacture of small incandescent lamps, the interest in which he has assigned to the Kellogg Switchboard and Supply Company, of the same place. The object of the invention is to provide means for increasing the output or number of lamps that can be readily pumped in connection with each fork, to decrease the necessity for the employment of skilled labor in order to attach and detach the lamps, and to decrease the liability of breaking the pump, as well as to prevent the necessity of repumping the lamp. In the accomplishment of these objects, a plurality of glass prongs are provided, to which the



Method for the Manufacture of Small Incandescent Lamps.

lamp bulbs are individually attached by means of suitable sealing-off or, rather, tipping connections, and which prongs are themselves adapted to be attached by suitable sealing-off connections to the fork. The lamp bulbs are thus easily attached to the light and easily handled prongs by a comparatively unskilled operator, instead of being individually attached to the forks used in the old method of pumping. The prong carries a contraction of suitable size for sealing-off from the fork, thus obviating the necessity for making a contraction for each individual lamp. This saves much time in attaching the lamps, as well as detaching them after the pumping process is completed. In order to detach the lamps after pumping, the entire group is sealed off from the fork at the contraction, thus incurring the liability of breaking the pump but once for each group of lamps instead of once for each individual lamp. Owing to a less number of branches of the fork being required for the prongs than for the individual lamps of old, the workman has more space in which to perform the sealing-off operations and with consequent less liability to failure.

An improvement in pliers has been invented by Charles J. Carlsen, of Chicago, Ill., and the patent obtained thereon has been assigned to Western Electric Company, of the same place. The object of the invention is to provide a tool which will be especially adapted for use in repairing spring-jacks and the like in telephone switchboards. The pliers are made from a rod of spring metal, such as steel bent into a loop, with its ends brought together to form the jaws. A pin passes transversely through the jaws at a short distance from their ends, and cross-pins

A New Design of Pliers.

are passed through the pin outside the jaws, whereby the pin forms a link to confine the jaws. The central portion of the pin is enlarged to form a distance-piece interposed between the jaws, the jaws being thus fulcrumed at the pin. The pliers are self-locking, the jaws being normally held together by the distended spring-loop. Squeezing the two arms of the loop toward each other rocks the jaws upon their fulcrum and causes them to be separated, so that a wire, jack-spring or the like may be passed between them. Then when the pressure on the spring-loop is removed the loop distends and forces the jaws together to grasp and hold the object.

Water Power in Germany.

A report from United States Consul Joseph J. Langer, at Solingen, Germany, states that the German Government is planning a complete investigation of water power in Germany, to find out what the resources are and to what extent they are being utilized. Water-level observations since the year 1896 are being compiled, measurements of flow are being made, and reports are being obtained from water-power users, giving the size of their installations and the purposes for which they are used. These reports will show which branches of trade should receive the first attention in having water supplied to them for power purposes, and the state itself will be placed in a position to aid financially in utilizing these valuable resources which are now lying dormant.

Cable Cutting.

In the current issue of the proceedings of the United States Naval Institute, an article on "Cable Cutting" is contributed by Captain C. F. Goodrich, U. S. N. The reasons for cutting a cable are given, and methods of carrying out the work described, together with some of the author's interesting experiences when he was detailed to cut the Spanish cables during the recent war with Spain. Equally important with interrupting the enemy's communications is the maintaining of one's own. For both objects a specially equipped vessel is highly desirable. Captain Goodrich advocates and believes that in a very short time a cable vessel will be considered an essential part of every properly equipped squadron.

Reviews of Current Engineering and Scientific Literature.

Experimental Determination of the Electrical Field within an Electrolyte.

The presence of an electrical field within an electrolyte has been shown by Herr von Wladmir von Nicolajew. His apparatus consists of a glass vessel filled with nitro-benzol, within which is floated an inverted bell jar. This is held in place by a wire attached to the bottom of the outer vessel. A potential is applied by means of two electrodes placed in the nitro-benzol at diametrically opposite points. If, then, a strip of metal is suspended within the inner vessel, it will turn so as to lie in the plane containing the electrodes. If it be held at an angle to this plane, the inner vessel will be set into motion, and will revolve until it is stopped by the torsion of the wire. This effect is not due to the presence of the electrodes, as it is not shown when the electrodes are held outside of the outer vessel.—*Translated and abstracted from Physikalische Zeitschrift (Leipsic), April* 15.

A New Mercury Arc Lamp for Automatic Lighting.

Before describing his own design of mercury lamp, Dr. Heinrich Paweck considers the earlier devices, beginning with Way in 1860. The type of lamp developed by the author is interesting principally from the method adopted to start it. The lamp consists of a horizontal tube, slightly bent, and having a reservoir for mercury at each end. The leading-in wires are sealed in at the reservoir, and are extended within the tube until they nearly meet in the centre. The tube is placed horizontally, with the concave surface up, and supported by means of two glass rods fused to the tube so as to form a vertical axis. Each of these rods passes through a vessel containing mercury, which forms a collector ring. Wires run from these vessels to the terminals of the tube. The lamp is held with the tube horizontal by pivot bearings, and is revolved by means of a small motor. When the circuit is closed, current passes in through the leading-in wires and through the tube by means of the platinum wires and a mass of mercury lying in the centre, which makes a metallic connection between these wires. As the lamp is revolved by the motor, centrifugal force throws this mercury out to the ends of the tube, thus setting up the arc. The lamp then presents the appearance of a luminous disc.—*Translated and abstracted from the Zeitschrift für Elektrochemie (Breslau), April* 29.

Should Technical Cases Be Tried before Ordinary Juries?

The question whether an ordinary jury is competent to pass upon technical questions is raised here by Mr. H. F. Wilson, Jr., who contends that, since by far the greater number of jurors are entirely unfamiliar with technical terms, it is impossible for them, during the time during which testimony is being taken, to understand fully the matter in dispute, and therefore the verdict will be more or less of a guess. The author suggests that all technical cases requiring expert testimony should be referred to or tried before a board or jury composed of competent engineers, and that this board should be established by due process of law, and should consist of three, five or seven members. The board should be allowed a reasonable compensation per diem and expenses. The author believes that by this method much time and energy and money would be saved, and that something like justice would be done.—*Abstracted from the Proceedings of the Engineering Association of the South (Nashville), March.*

The Electrical Engineering Laboratory at the Southwestern Polytechnic, London.

A very interesting description is here given of the engineering laboratories of the Southwestern Polytechnic, London. The electrical laboratory is divided into three sections: a large laboratory for testing instruments and the measurements of electrical quantities; a dynamo room for the study of electrical machinery, and an advanced laboratory where the standard instruments are kept, and where more advanced experimental researches are carried out. There are also rooms for photometry. The large laboratory is equipped with benches, to each of which circuits are run, by means of which various sources of supply are made available. In the dynamo room the machines have been arranged so that any one of them can be used as a motor to drive its neighbor as a generator. A group of students carrying on a test is independent of any other group of students which may be working at the same time. There are over twenty machines in this laboratory. In all cases, students make their own connections, and each student is required to make a systematic series of measurements dealing with the various points in the design and behavior of dynamos and motors. The machines available for this work cover nearly all types of alternating and direct-current dynamos and motors and auxiliary apparatus. Power is supplied to this laboratory from the main lighting plant of the school, which is separate from the laboratory.—*Abstracted from the Mechanical Engineer (London), May* 7.

The Production of an Electrostatic Revolving Field.

In this article MM. C. E. Guye and P. Denso discuss theoretically the production of a revolving electrostatic field by means of high voltages. The subject is treated in the way usual with this similar subject of a rotating magnetic field. The assumption is made that two or more sinusoidal electromotive forces are available, differing in phase by ninety degrees, or as may be required to produce the desired result. To obtain a rotating field actually, a single source of electromotive force is sufficient. By applying this to the complex circuit consisting of two sections connected in series—one of these being an inductance and the other a capacity shunted by a resistance—and properly adjusting the relations of the parts of the circuit, the electromotive force acting across the condenser terminals will be brought into quadrature with that acting across the inductance. These two electromotive forces are applied to four segments or electros, arranged in the way usual in quadrant electrometers. Two adjacent segments are each connected to one of the leads from the outer terminals of the composite circuit. The other two circuits are connected to the inner point where the inductance, the capacity and the resistance are joined together. Assuming the two electromotive forces are sinusoidal, the electrostatic field set up within the four segments by them will be uniform only when they have the same value and are exactly in quadrature. This condition may be obtained by adjusting the resistance and the capacity. To determine whether this field is circular or elliptical, the authors construct the apparatus in the following way: the four electrodes consist of four circular discs, mounted on rods and inserted within a

brass cylinder, from which they are insulated. They may be adjusted horizontally. Within the centre of this arrangement a small aluminum rod is suspended in a horizontal position by means of an aluminum wire attached to a quartz fibre. Below this is a small mirror, and below the mirror is a damping vane. In applying the electromotive forces to this arrangement, the electrostatic field set up has no effect upon the orientation of the suspended field, providing the resulting field is circular. If it be elliptical, the aluminum rod tends to set itself in the direction of the major axis. The mirror is protected from effects due to the electrostatic field by means of a shield placed above it. —*Translated and abstracted from L'Eclairage Electrique (Paris), May 7.*

The Continuous-Current System and the Single-Phase System for Electric Traction.

The attention which the single-phase series motor is receiving at this time leads Mr. H. M. Hobart to defend the direct-current series motor. He believes that, in the comparisons made, the latter machine has not received quite fair treatment, since the possibility of improving the direct-current system has not been considered. It is generally assumed that the direct-current motor will operate at 650 volts. If this could be increased, fewer substations would be necessary, and these would be more uniformly loaded. By operating in series and adopting rheostatic control, the allowable voltage with the present motors would be 1,300. This, the author thinks, would throw the advantage on the side of the direct-current system. He takes the estimate made by Mr. P. M. Lincoln, and recomputes the continuous-current system for 1,300 volts at the car. He finds that, for this system, the electrical equipment of the power station would cost $41,000; the low-tension distributing system would cost $182,000; the car equipment would cost $66,000; and the total first cost for the electrical equipment would be $289,700. The corresponding figures for the alternating system are $323,050. He estimates that the operating expenses for the direct-current system would be $51,865, the corresponding figure for the alternating system being $55,820. This shows that the direct-current system designed for 1,300 volts would have an advantage of thirty per cent in the first cost of electrical equipment, and of seven per cent for total yearly operating expenses for power and for maintenance of electrical plant. Considering the disadvantages of the alternating motor, this machine has a larger commutator than the direct-current machine, since it must allow for additional parasitic losses. Moreover, since, for satisfactory operation, the voltage of the armature is low, and since the power-factor is less than unity, the commutator will have to be still larger. The internal losses of the single-phase motor are greater than those of the direct-current machine; hence, the former machine must either run hotter or be larger. The auxiliary apparatus required by the alternating motors on the car is heavy and expensive, and introduces further losses. Mr. Hobart thinks that Mr. Lincoln, in his paper, overlooks the fact that single-phase generators cost thirty per cent more than polyphase generators for the same rating and guarantees, and that he also overlooks the increased cost of low-periodicity transformers. The single-phase generating plant described in Mr. Lincoln's paper should have been more liberally proportioned. The author believes that the depreciation in the alternating-current motors is larger than in the direct-current equipment, since the voltage per turn in the field spools is greater, and commutation is less satisfactory.—*Abstracted from the Electrical Review (London), April 29 and May 6.*

The Control of Furnace Combustion.

The determination of the amount of carbon dioxide contained in the combustion gases affords the best criterion for the economical working of a furnace. There are several types of apparatus devised for this purpose, some of them being used when only occasional determinations are desired. There are others which give continuous readings, one of the most recent being the Krell-Schultze, which is described in detail in this article. The device consists essentially of two long glass tubes connected with an aspirator. Through one of these tubes air is drawn, and through the other, gas from the chimney. The tubes are cross-connected at the top and fitted with regulating valves. At a point near the bottom of each tube, a connection is led to a delicate pressure gauge, which consists of a flat cylindrical box filled with colored alcohol, the differences in pressure being shown by the movement of the alcohol in a small inclined glass tube. The connections to this gauge are made by means of flexible tubing, the tube through which the air passes being attached to one end of the indicating tube, while the box containing alcohol is connected in a similar way to the tube through which the flue gases pass. In this way, since the one tube contains the air, and the other contains the furnace gases, which have a higher percentage of carbon dioxide, the column of gas in the latter tube will be somewhat heavier than in the other. This will cause a slight difference of pressure and produce a movement of the alcohol in the indicating tube. By means of a scale, and by a proper adjustment of the apparatus in the first instance, the percentage of carbon dioxide in the flue gases can be read off directly. Or, by passing continuously a sensitized band of paper behind this column, a continuous record may be made. This device has been tested by Professor Bunte at the technical high school, Karlsruhe, and he has found that the results agree very well with those obtained from chemical analysis.—*Abstracted from Engineering (London), May 6.*

The National Electrical Contractors' Association.

The fourth annual convention of the National Electrical Contractors' Association of the United States will be held at St. Louis, Mo., September 14, 15 and 16, 1904. On account of the low rates granted by the several passenger associations between St. Louis and other points, it has been unnecessary to secure a special rate on the certificate plan for the benefit of delegates and visitors to this convention.

A special convention train will leave Grand Central station, New York city, on Saturday, September 10, at 1 o'clock P. M. for St. Louis, where it is due to arrive Sunday, September 11, at 6.45 P. M. Special provision is being made for the comfort of ladies traveling on this train.

Headquarters for the eastern delegates will be at the Washington Hotel, Washington avenue and King's Highway Boulevard, St. Louis. Train and room reservation should be made at once. Communications should be addressed to Mr. Alexander Henderson, master of transportation, 527 West Thirty-fourth street, or to Mr. Milton C. Roach, general passenger agent, 1216 Broadway, New York city.

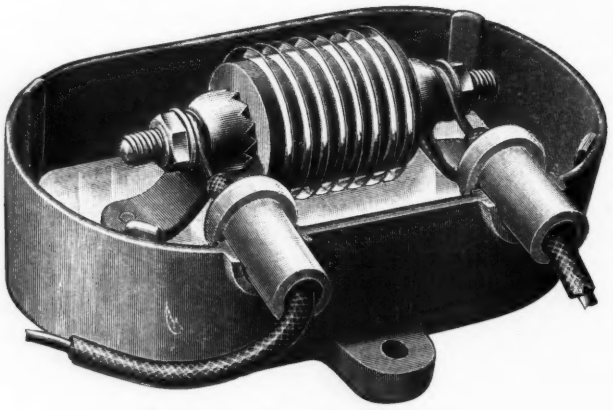
An atom is the smallest possible amount of matter into which an element can be divided. A molecule is made up of atoms. Thus one atom of iron combines with two of sulphur to form pyrite (iron sulphide). It is written FeS_2. An ion has been described as an atom or group of atoms, which are positively or negatively charged with electricity.

INDUSTRIAL SECTION.

ILLUSTRATED DESCRIPTIONS OF NEW AND STANDARD ELECTRICAL AND MECHANICAL APPARATUS.

The Shaw Non-Arcing Lightning Arrester.

The accompanying illustration shows the new form of non-arcing lightning arrester manufactured by the Shaw Engineering and Manufacturing Company, Newark, N. J. This lightning arrester breaks up the discharge into such small parts that there is practically no current flowing to the ground after disruption. As may be seen from the illustration, the arrester consists of two binding-posts and



NON-ARCING LIGHTNING ARRESTER.

two conducting electrodes, holding between their respective serrated edges a series of disc-shaped carbon and mica washers, alternately placed. The carbon discs are mounted on an insulating washer, and the mica plates extend down between these insulating washers to the bolt which retains the whole breaker in place. The bolt is of non-conducting material, such as fibre. The ends of the bolt pass through the upright supports of the conducting electrodes.

The current comes to the breaker through the line wire, where it spreads through the flat support to the electrode. The current is broken into small discharges from the serrated end of the electrode, and diverted into the flat discs of carbon. Here it is broken up into infinitesimal sparks in passing from one carbon disc over or through the insulator to the succeeding carbon disc, and so on until it is received at the serrated ends of the opposite electrode, from which it is led off into the ground through a ground pipe.

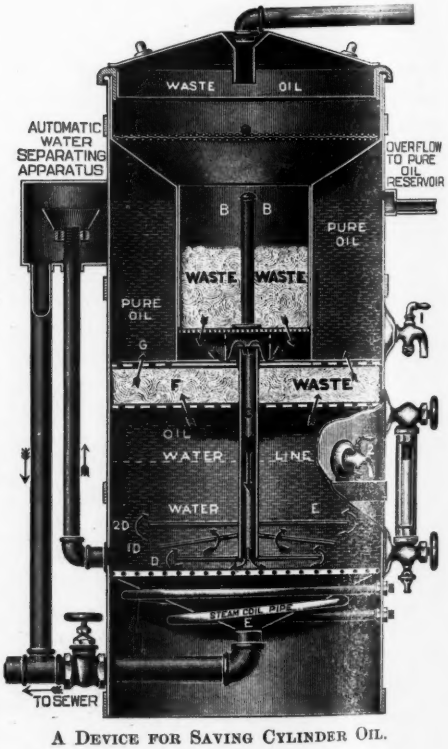
This lightning arrester, as may be seen, contains no moving part, and when placed in a box the connections are made from the head-pieces of the serrated castings. In the switchboard type, the connections pass through the base of the apparatus.

The Franklin Institute, Philadelphia, Pa., through its committee on science and art, awarded the Edward Longstreth medal of honor to Mr. H. M. Shaw for the production of this arrester.

A Device for Saving Cylinder Oil.

The Burt Manufacturing Company, of Akron, Ohio, has for some years been making what is designated as its "Style B" oil filter. This filter, the manufacturer states, will take the condensation from oil separators and exhaust heads, and automatically separate the oil from the water, purifying the oil at the same time; the pure oil going into the pure oil reservoir, and the water running from the drip into the sewer. The filter is made in several sizes, in capacities from 3 to 500 gallons per day. It is used by large factories, installations being placed with the National Cash Register Company, United States Steel Corporation, Westinghouse Air Brake Company, the Allegheny County Light Company, the Edison Electric Light Company and other large institutions.

The operation of the apparatus is as follows: the oil and water are poured in the top of the filter and pass into chamber B through a layer of waste. This waste collects all the heavier impurities of the oil. From this point they pass through the perforated bottom of the chamber B and down, in the direction shown by the arrows, into the tube C, and from here on to the filter plate D, where the increased weight of the water has a tendency to keep the oil back in the tube C. The pressure of oil in the chamber B forces it down and spreads it out over the plate D in the thin film, which constantly changes surface and grows thinner as it travels from the centre to the circumference of the plate D, thus exposing every particle of waste oil to the action of the water. It then flows upon plates D^1 and D^2, going through the same process in each case. When the oil leaves the filter plate D^2, it is in a finely divided state of separation and thoroughly mixed with water, which washes it out and from which it separates by gravity. All the remaining impurities which settle in the chamber E can be removed by opening the gate valve at the bottom of the filter, which drains off all the water and dirt. From the plate D^2 the oil again filters through the stratum of filtering material F, and from there it raises to the pure oil chamber, and then flows to the oil reservoir. The water is automatically separated after it passes



A DEVICE FOR SAVING CYLINDER OIL.

down the tube C and reaches the bottom of the plate, as the oil being lighter than water, just as soon as it reaches the bottom of the filter it immediately rises, and the surplus water passes into the tube which leads to the automatic water-separating device.

Walker Magnetic Chucks.

For surface grinding of small pieces, no apparatus has been of such utility as a practical form of magnetic chuck. The great ease with which this apparatus can be handled, and the elimination of all forms of adjustment render it peculiarly adaptable for the handling of small pieces. After a piece of hardened steel had been laid upon the magnetic chuck, the fact that a remnant of magnetism is left in the steel does not prove a drawback, in that a simple demagnetizing machine has been designed, and is invariably a part of the equipment of a machine shop using a magnetic chuck. In addition to a large line of flat chucks, there are built by O. S. Walker & Company, of Worcester, Mass., eight sizes of rotary chucks, from seven to twenty-seven inches in diameter, for discs, washers, piston rings, etc.

Fig. 1 shows a standard type of surface grinding chuck. The holding face of this chuck is four and one-half by sixteen inches, and its height is three inches.

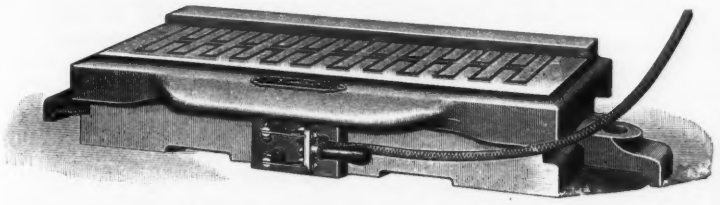


FIG. 1.—STANDARD TYPE OF SURFACE GRINDING CHUCK.

FIG. 2.—DEMAGNETIZER.

Fig. 2 shows the demagnetizer which is used to divest the hardened steel of any trace of magnetism which it may have as a result of its contact with the magnetic chuck. This apparatus consists of a quartered-oak box on a cast-iron base. Upon this base are mounted the journals for the revolving magnet. By means of a pulley, the magnet is revolved at a high rate of speed. The cover of the apparatus is detachable, and supports a mass of laminated plates of thin sheet metal, which are attached to the two top plates shown in the illustration. The work to be demagnetized is laid across the top plates and lifted away and lowered again. This apparatus has the effect of alternating the polarity of the work, which leaves behind a portion of its magnetic charge each time it is withdrawn out of the magnetic field.

FIG. 3.—SHOWING AN AUTOMATIC MOTOR-DRIVEN SURFACE GRINDER, WITH MAGNETIC CHUCK BUILT IN PLATEN.

Fig. 3 shows an automatic motor-driven surface grinder. It has a magnetic chuck built in the platen, and so arranged that it is automatically magnetized and demagnetized as the machine is started or stopped. The grinder spindle has a motor coupled directly to its rear end, is ring-oiled, and the whole has a micrometer vertical adjustment. The carriage and platen are operated by a motor in the base of the machine, and all the feeds are automatic at each end of the circuit.

The platen has a variable speed, and can be instantly changed from full automatic to automatical longitudinal feed, without the cross feed, or to simple hand feed. The whole machine will automatically stop if the electric power fails for any reason, the switch automatically opening, so that no harm can come to the motor should the current suddenly come on again. The machine is mounted upon casters, and may be readily moved from place to place in the shop where it will be most convenient.

These machines are made for direct current, either 110 or 220 volts, and various combinations of wiring may be effected with resistance of different capacities for different forms of service.

The Frost Storage Battery Grid.

During the past several years the Patent Office has granted a large number of patents on storage battery grids which purport to be light in weight and, at the same time, hold the active material or paste securely in place. It would seem that Mr. George W. Frost, of Columbus, Ohio, has made a real advance in battery grid construction and that the patent granted him April 12, covering a new design and illustrated herewith, is deserving of attention.

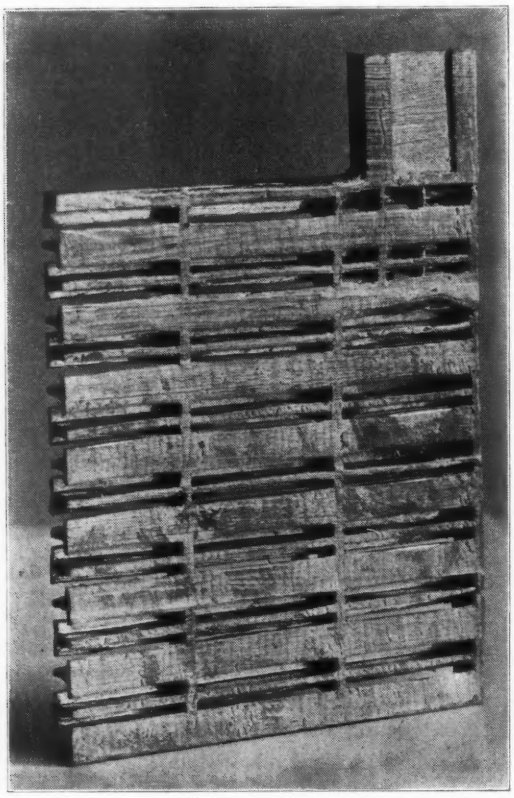


FIG. 1.—PLATE SHOWING CONSTRUCTION OF GRID.

Fig. 1 shows a plate with one edge sawed away so as to clearly show the construction of the grid. It is cast all in one piece in a two-part metal mould. Vertical ribs are placed at short intervals, and to secure proper strength two short ribs are cast just under the terminal lugs.

For stationary purposes plates are cast about 0.32 of an inch in thickness and milled off on either side, by means of a broad milling cutter, about 0.03 of an inch, so that the finished plate is 0.26 of an inch in thickness. For light-weight automobile batteries the grids are cast 0.25 of an inch and milled down to nineteen thousands of an inch in thickness. The illustration shows a heavy plate of the stationary type. From fifty to seventy per cent, by volume, of active material or paste can be forced in through the narrow slits on either side of the grid, and after the active material has been properly hardened and formed it is practically impossible to remove it from the narrow openings. It will not disintegrate materially, due to the action of the gases formed or by the swishing of the acid against the surface of the plate, in the case of automobile batteries. About sixty per cent of the exposed surface of the plate is metallic lead, which in time becomes oxidized and materially increases the capacity of the electrode.

A series of tests was conducted to ascertain whether or not cells having plates of this design would be capable of absorbing and giving out the current as readily as other standard grids of the pasted type which have, proportionately, a much larger surface of exposed active material. These tests, the maker states, showed that the broad strips across the surface of the plates in no way interfere with the capacity, and that there is ample circulation of electrolyte through the interstices of the grids.

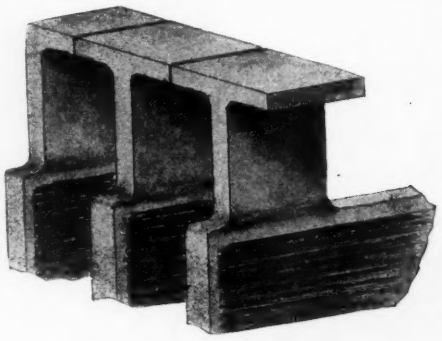


FIG. 2.—SHOWING T-SHAPED TERMINAL LUGS.

The design of the plate is such that it expands evenly as the active material increases in volume. The moulds used in casting are simple and inexpensive, and one workman can cast several hundred medium-sized plates per day.

Fig. 2 illustrates the T-shaped terminal lugs which are cast integral with the grids, so that in lead-burning the plates together, they can be lined up as shown and a mould placed around the joints and the lead melted all the way through, ensuring perfect connections.

The Frost grid has been adopted by the Columbus (Ohio) Storage Battery Company as its standard for plate construction, and it has already installed several large private lighting plant batteries having plates of the new design.

Protection for a Large and Expensive Power Plant.

The largest engines at the Louisiana Purchase Exposition, those furnishing the power for lighting the buildings, grounds, cascades, operating the intramural railway and the motors in Machinery Building namely, the four large vertical Westinghouse, the Hamilton-Corliss and Fleming four-valve, made by the Harrisburg Foundry and Machine Company are all equipped with the Monarch engine-stop and speed limit system which is a protective device for engines to prevent overspeed and check racing and to shut down from a distance in case of accident from any cause.

This device, called the Monarch engine-stop and speed limit system, manufactured by the Consolidated Engine-Stop Company, 100 Broadway, New York, consists of four different types of engine-stops, all of which will be shown and demonstrated at the World's Fair, St. Louis, in its own exhibit in Machinery Building, block 44, aisle G.

The "Monarch" type, which is very well known, there being about fifteen hundred in use, will be shown on both horizontal and vertical throttle valves, and the power to operate it is a weight.

The "Corliss" type is attached to the governor of an engine and is operated by steam.

The new "Balance valve" engine-stop is designed to close a quick closing balance valve placed anywhere in the main steam pipe and operates by a small weight. This valve is closed automatically by the Monarch speed limit attached to main shaft, the same as one is done with the other types of stops.

The newest innovation in engine stops brought out by the Consolidated Engine-Stop Company is a stop operated by electric motor. It is connected with the throttle by a sprocket chain and will close any size valve no matter how hard it turns and will automatically stop when the valve seats. It is especially designed for large units and will close a valve quickly and easily that ordinarily takes two men to close.

All of these different types of stop will be wired with Consolidated Engine-Stop Company patent system with test boards which enables the wires throughout the building and the batteries to be tested from the engine room, and if weak batteries or broken wires are discovered on the test the stops can be operated to shut down the engine either automatically by the speed limit or any of the circuit-closers pending repairs to batteries and wires.

The whole is a most interesting and instructive exhibit and should be seen by all central station managers, electricians, mill owners and engineers.

CURRENT ELECTRICAL NEWS

DOMESTIC AND EXPORT.

JAPANESE ELECTRIC ENTERPRISE—Two undertakings are projecting by the Sanyo Railway Company, of Japan, which it is expected will mean the purchase of considerable equipment in the United States. The company proposes to build a line between Shiminoseki and Fusan stations, a distance of about 120 miles.

A MERGER OF STREET RAILWAY LINES IN NEW HAVEN, CT.—A combination to be known as the Consolidated Street Railway Company will be effected in New Haven, Ct., very soon. This will consist of the Worcester & Eastern Street Railway Company and the Fair Haven & Westfield Railroad. The new company has authority to furnish light and power to any public or private corporation.

SOUTH AMERICAN POWER PLANTS—The La Guayra Electric Light Company, of La Guayra, Venezuela, is placing orders for electric equipment to be installed in Venezuela's water-power and steam-power plants which it is about to build. Mr. C. G. Palacios, of Caracas, who was at one time identified with the United Electric Company, of Newark, N. J., is acting as consulting engineer.

TO BUILD A LARGE POWER PLANT IN KANSAS—Work has been commenced on a large dam at Lowell, Kan., for the Spring River Power Company. The dam which is to be built at Lowell will be 400 feet in length, thirty feet wide at the bottom, twelve feet wide at the top, and twenty-four feet high. It will be built of boulders, sand and cement. A company has been organized for the purpose of supplying electric power to the mining plants and other industries of the mining district.

NEW OREGON POWER PLANT—Plans are under way for the construction of a tower and power plant in the Black Cañyon, six miles above Emmett, Ida. It is estimated that the minimum horsepower generated at the lowest stage of the river will be 18,000, while the maximum will exceed 40,000. It is intended to supply electric power to the towns adjacent to the Payette valley and to the mines of Pearl, Ida. Power will also be supplied for an electric railroad which will be built from Payette through the upper valley.

WIRELESS TELEGRAPH STATIONS ON THE ST. LAWRENCE RIVER—The American Marconi Company has completed negotiations with the Canadian Government, on behalf of the Canadian Marconi Company, for the establishment of a system of seven wireless stations between Montreal and the Straits of Belle Isle, as an aid to navigation. Four stations are to be put up in June, July and August, and the whole system is to be ready for the opening of the navigation season of 1905. All of the passenger ships are to be equipped with the Marconi apparatus.

LAKE SUPERIOR DECISION—On May 20 Judge Platt issued an order in the United States Circuit Court, upon the motion of counsel for John G. Carruth, receiver of the Consolidated Lake Superior Company, directing the receiver to withdraw an action instituted by him, and now pending in the Supreme Court of the state of New York. The order also directs him to execute and deliver to Speyer & Company releases and other instruments required of him by an agreement with that firm, upon assurances satisfactory to the receiver and counsel, that the conditions required to be performed, either by Speyer & Company or by the reorganization committee, or by any other person or corporation, have been or will be fulfilled.

INDEPENDENT TELEPHONE NOTES—It is stated that a number of independent telephone men are at work upon the details of a plan to form an independent long-distance telephone service between the Atlantic seaboard and the Pacific coast. Mr. S. P. Sherin, of the New Long-Distance Telephone Company, Indianapolis, Ind., is chairman of this committee. Associated with him are said to be Colonel J. B. Powers, Independent Long-Distance Telephone and Telegraph Company, Louisville; J. B. Hoge, United States Telephone Company, Cleveland; C. M. Forster, Kinlock Long-Distance Telephone Company, St. Louis; J. G. Splane, Pittsburg & Allegheny Telephone Company, Pittsburg, and J. S. Braily, Western Independent Telephone Company, Kansas City. The plan is to take in such cities as New York, Baltimore, Albany, Columbus, Toledo, Grand Rapids, Chicago, Minneapolis, Milwaukee and Cincinnati.

MEXICAN ELECTRICAL NOTES—The Electra Sociedad Anonyma, which controls the franchise for electric lighting and tramways in the city of Guadalajara, Mexico, is contemplating the installation of an electric line in this city and its suburbs as soon as arrangements can be made for the delivery of the necessary machinery. The concession under which the company has been operating its lighting plants and tramways has six years to run. Arrangements have been made for the investment of $1,000,200 for machinery and improvements. The last year in which mule cars were in service in Guadalajara, 17,000,000 passengers were carried. Upon the introduction of electric lines 33,000,000 passengers were carried. A new company has been formed to reorganize the working of some of the famous old mining companies in the Guanajuata district. The company has a capital of $7,000,500. New machinery will be bought and electrical apparatus will be extensively used. An electric track system is to be built at Mazatalan located in the state of Sinoloa, Mexico. At present there is a two-mile mule tramway in Mazatalan. Mr. J. Maxenim, who has secured the necessary permit to construct the lines, is about to make a trip to the United States for the purpose of placing contracts for equipment.

EXTENSIVE CHINESE ELECTRIC TRACTION SYSTEM—The municipal council of the foreign settlements at Shanghai, China, is inviting proposals for a concession for operating and constructing about twenty-three miles of electric trolley lines in the streets of Shanghai. Tenders for this franchise were originally asked for in 1898, when a contract was entered into between the municipal authorities and the Brush Electrical Engineering Company, Limited. This concern is now controlled by the British Electric Traction Company, Limited, of London. The new conditions require a deposit of $25,000 upon signing the contract, as a guarantee that the contractors will carry out the specifications. The road comprises five specific sections, about five and three-quarters miles of double track, and ten and three-quarters miles of single track. This is to be equipped with span-wire construction for double track, bracket construction for the single track, and with iron or steel poles. The parties putting in the road are permitted to collect from each first-class passenger six cents for a maximum distance of one and one-half miles, and for each second-class passenger, two and one-half cents. A yearly rental of $500 per mile of single track and $750 per mile of double track is required to be paid to the Shanghai council.

ELECTRIC RAILWAYS.

BUFFALO, N. Y.—An electric road running from Addison to Olean *via* Woodhull, Rexville, Whitesville and Wellsville, thence to Bolivar, connecting with the line of that village to Olean, is being projected.

SYRACUSE, N. Y.—Consent to construct the Rochester, Syracuse & Eastern line has been secured all the way from Rochester to Newark and from Newark to Clyde, and as soon as the company gets its consent from the state railroad commission work will be pushed.

BELLEFONTE, PA.—A charter has been granted to the Clearfield & Curwensville Street Railway Company. The proposed line will be twelve miles in length, and will extend through the borough of Curwensville, follow a route along the river, pass through Clearfield, and will be constructed at once.

LITTLE ROCK, ARK.—The Harrison Central Railroad Company has been organized for the purpose of building a line to connect with the White river road, near Keener, a distance of ten miles. The capital stock is $150,000. The corporators are George W. Keene, of

St. Louis; T. N. Chenoweth, H. A. Crandall, Charles M. Greene, Frank R. Greene, John A. Bunch, A. L. Lopp, L. A. Saffer, Frank Pace and E. S. Alexander, of Harrison.

LANCASTER, PA.—At a meeting of the stockholders of the Lancaster and Mount Joy Railway companies the two were merged, under the name of the Lancaster, Rohrerstown & Mount Joy Railway Company. Charles B. Keller, vice-president of the Conestoga Traction Company, which controls Lancaster County's trolley system, was elected president.

CUMBERLAND, MD.—Surveyors are now at work on a proposed trolley line beginning at Hollidaysburg and to run to Bedford, ending at Cumberland. The line, if built, will connect Cumberland with Altoona, a line already being in operation between the latter place and Hollidaysburg. The route to Cumberland is *via* Bedford Springs and the Cumberland valley.

DES MOINES, IOWA—The Arnold Electric Power Station Company reports favorably on the construction of the Iowa City, Kalona & Washington electric line, and it is probable that work will be started soon. It reports thirty miles of single track and three miles of turnouts and switches, with one power-house and three substations. The road will be standard gauge, laid with ninety-pound steel.

WILMINGTON, DEL.—The announcement has been made that the West Chester & Kennett Railway Company has secured a right of way through all of the properties along the line, and that the line is to be built, with the expectation of running the first car on the fourth of July. It will then be possible to go all the way by trolley from Wilmington to West Chester.

NEW CASTLE, PA.—A complete reorganization of the Pennsylvania & Mahoning Valley Electric Railway Company, which controls the local and Youngstown street railway systems and about 100 miles additional trolley tracks throughout eastern Ohio, has been effected. Superintendent M. E. McCaskey, in charge of the local system for two years, is made second vice-president and general manager of the entire system.

NASHVILLE, TENN.—The secretary of state has granted a charter to the Harriman & Oliver Springs Railroad Company, capitalized at $10,000. The incorporators are James E. Rodes, Sam P. Sparks, Claude E. Headrick, Sam C. Brown and Robert B. Cassell. It is proposed to build a road from Harriman to Oliver Springs, Tenn., passing through Webster, Mays and Poplar Creek. The entire road will be in Roane County.

ASHLAND, OHIO—It is announced from Mansfield that the work of constructing the Mansfield & Eastern Traction Company's electric line from Mansfield to Ashland, by way of Mifflin and Petersburg Lake, will begin about June 1. The company has entered into a contract with the Reisenger, Prather Company, of Pittsburg, to build the line, which is to be in operation within a year. Cleveland capital is interested in the project. A bonded indebtedness of $450,000 has been arranged for, and it is stated that about one-third of that amount has already been underwritten.

PITTSBURG, PA.—The proposed new traction line from East Pittsburg at a special meeting of the Wilkins township commissioners, held at Mucklerat, secured rights of way through the entire township. The new company is known as the East Pittsburg, Turtle Creek & Wilkinsburg Street Railway, and will build a railway from Turtle Creek and East Pittsburg over the Wilkins township road into Wilkinsburg. It will reach new territory in the Turtle Creek valley and also open up the country along the old Greensburg and Philadelphia pike, taking in the old village of Beulah Church, Coalville, Hannatown, Mucklerat and Duquesne mines. The line is to be completed before fall.

JAMAICA L. I.—The New York & Queens County Railroad Company has filed in the county clerk's office a map and description of the proposed extension of its double-track trolley line from Newtown to Jamaica. The company has already obtained a number of the necessary consents of adjoining property owners and has made application to the board of aldermen for the franchise. Mechanics are at work putting in the foundations for the 1,200-horse-power engine being installed at the company's power-house in Long Island City, which will add forty per cent to the present capacity of the road. The substation at Flushing is also being greatly enlarged, work having begun. Upon the completion of this substation through cars will be run from Long Island City to Jamaica without change.

AUGUSTA, GA.—The Augusta & Elberton Railway Company was organized recently at a meeting of the stockholders, when Bruce Young was elected president. The board of directors, elected at the same time, is as follows: C. Bruce Young, F. T. Lockhart, J. E. Hogan, W. C. Wardlaw, A. F. Heath, R. E. Ramsey and John Zellars. Construction of the road will begin in June, and the first twenty miles will be completed by December 1. The work on this section will be greatly facilitated, due to the fact that the roadbed was graded by the old Augusta & Chattanooga road. A resolution was passed at the meeting of the directors calling for a meeting of the stockholders on June 2, to provide for the issue of $150,000 first mortgage bonds, which, it is stated, have largely been subscribed for.

DES MOINES, IOWA—An electric line between Des Moines and Waterloo, in operation by 1906, is the plan of a company recently incorporated at Waterloo. The road is being promoted by Indiana and Eastern capitalists with assistance from business men at Waterloo and Marshalltown. The road will probably be built *via* Grundy Center and Marshalltown. Surveyors will soon begin work on the line, and it is hoped to begin the construction at Waterloo within a short time. The road will be about 125 miles long. It will be built for both freight and passenger purposes, and will be a connecting link between the extensive interurbans of the Waterloo & Northern Rapid Transit Company at Waterloo, which has lines to Waverly and other northeastern Iowa points, and the interurbans which will centre in Des Moines.

PERSONAL MENTION.

MR. THOMAS H. HUBERT, of Macon, Ga., has been appointed manager of the Western Union interests at Waycross, Ga.

MR. G. H. KENDRICK, electrician of the Western Union Telegraph Company, Pittsburg, Pa., is installing a new main office equipment for his company at Wheeling, W. Va.

MR. WILLIAM F. STAUFFER, secretary and general manager of the Enterprise Telephone Company, New Holland, Pa., has resigned his position and is succeeded by Mr. E. H. Martin.

MR. A. W. HUTCHINS, president of the Ballou-Hutchins Electric Company, of Providence, R. I., was a visitor to Chicago last week. Mr. Hutchins reports a large increase in the time switch business.

MR. GEORGE M. DUGAN, for many years connected with the Illinois Central Railroad as superintendent of telegraphs and telephones, has retired from the company and is succeeded by Mr. H. C. Grace.

MR. ARTHUR E. APPLEYARD has been made president of the Dayton, Springfield & Urbana and the Columbia, London & Springfield electric roads in Ohio to succeed Mr. John S. Harshman, resigned.

MR. CHARLES T. YERKES, who arrived from England recently, states that the lines in the metropolitan district, which is the key to the entire London underground railway system, will be ready for operation by January 1, 1905.

MR. CHARLES B. MARTIN, first assistant electrical engineer of the Brooklyn Rapid Transit Company, recently read a paper before the Brooklyn Engineers' Club, on "The Power Supply System of the Brooklyn Rapid Transit Company."

MR. J. G. WHITE, president of the electrical engineering contracting firm of J. G. White & Company, Inc., sailed for Europe on the North German Lloyd liner Kaiser Wilhelm der Grosse on May 24. Mr. White expects to be abroad for about three months.

MR. MAX LOBENTHAL, of the Economical Electric Lamp Company, New York city, made a trip to Chicago last week in the interests of his company. Mr. Lobenthal has experienced a prosperous season, and is sanguine of considerable extension during next year.

MR. A. M. BARRON, recently returned to Joplin, Mo., to take charge of the Southwest Missouri Light Company's plants. Some years ago Mr. Barron was connected with the company as manager, but was called away to accept a position with another company. The Southwest Missouri Light Company has enlarged its works,

and at present has generating stations at Webb City, Cartersville and Joplin, Mo. Extensive improvements are to be made in these plants, and Mr. Barron has been called to superintend the changes.

MR. W. D'A. RYAN, who is connected with the General Electric Company, Lynn, Mass., recently delivered an interesting lecture, in the lecture hall of the Columbian University, Washington, D. C., to the American Cotton Manufacturers' Association, on "Light and Illuminating Engineering."

MR. LOUIS J. MAGEE, director of the Allgemeine Elektricitäts-Gesellschaft and the Union Elektricitäts-Gesellschaft, of Berlin, is spending the summer in the United States, with headquarters at 25 Broad street, New York city. Mr. Magee has a large number of friends in this country who will be glad to extend to him a cordial welcome.

MR. CYRUS O. BAKER, JR., the platinum importer, sailed for Europe last week, and will spend the next two months abroad, visiting the capitals of Europe. Mr. Baker has been the master of transportation for the National Electric Light Association for many years past, but, because of his business requiring attention on the other side of the water, he was compelled to decline to continue in this office.

MR. E. H. McHENRY was recently elected fourth vice-president of the New York, New Haven & Hartford Railroad. The president of this road believes that the application of electricity to steam railroads will come in the near future, and as Mr. McHenry is particularly well versed in the adaptation of electricity to standard gauge railroad operation that his services are particularly desired in this direction.

MRS. WILLIAM C. GOTSHALL, wife of the president of the New York & Port Chester Street Railway Company, was seriously injured on Sunday, May 22, by being struck with a stone thrown by a boy on 106th street, New York city. Mr. Gotshall and a party were returning in their large automobile from a trip on Long Island, and as the machine was proceeding slowly through the crowded section of the city, the hoodlums began throwing stones, one of which struck Mrs. Gotshall, with the above serious result. At the present time she is in a precarious condition, and Mr. Gotshall is making every effort to bring the offenders to justice.

MR. H. F. FREVERT, who is well known in the machine tool field in this and in foreign countries and who was the efficient manager of the miscellaneous department of the Niles-Bement-Pond Company, New York, for some years past, recently tendered his resignation to the company and will enter into business for himself, in the Engineering Building, 114 Liberty street, New York city, N. Y. Mr. Frevert is to have charge of the New York office of the Norton Grinding Company, Worcester, Mass., manufacturer of grinding machinery and of the New York office of the Brighton Manufacturing Company, Shelby, Ohio, manufacturer of machinery for turning and polishing shafting, also of turned shafting and screw stock.

REAR-ADMIRAL GEORGE WALLACE MELVILLE has returned home after an extended trip abroad investigating the efficiency of turbine engines as a motive power for war vessels. As a result of his investigation, Mr. Melville does not favor the adoption by this government of the turbine engine for that purpose. This form of engine, he says, he believes to be still in the experimental stage and not until radical improvements have been made does he think it will be available. He further said, "I shall oppose the building of turbines for war vessels, except for experimental purposes." "The turbine is still in its infancy and there is not a single engineer that would be willing to stake his reputation on the work of the best one made." He also stated that so much of the turbine is still in the experimental stage, that the Cunard Line was unable to get a ship-building firm in Great Britain to build and guarantee the two twenty-four and one-half knot boats which it intended to have built. He also stated that "there is absolutely no question about the economy of the turbine for the electrical drive, because of its high speed, but as the propellers of a vessel must bear a certain proportion to the cross-section of the vessel, the propellers can not be put in a proper diameter and maintain this high speed of revolution. Very small propellers could be run at an exceedingly high number of revolutions, but instead of pushing the vessel through the water they slip and churn the water around them into foam with no commensurate driving power."

ELECTRICAL SECURITIES.

There is nothing to indicate any early change in the existing conditions in the financial district. The generally propitious weather experienced throughout the country has done much to encourage the hope that there will be a bountiful crop, despite the bad effects of the cold spring. It has often been prophesied that, following several years of activity, there would inevitably come a period of retrogression and shrinkage. This has been the case a number of times, but it appears that never before was the country in such good condition all around. Of course, along with declining interest in railroad and industrial securities, and with declining imports, there is a disposition to conservative production of commodities in general. This decreased production is conducive to lower wages, and this, in turn, to fewer expenditures and almost no speculation.

ELECTRICAL SECURITIES FOR THE WEEK ENDING MAY 21.

New York:	*Closing.*
Brooklyn Rapid Transit	46⅜
Consolidated Gas	209
General Electric	155
Kings County Electric	187
Manhattan Elevated	143½
Metropolitan Street Railway	111
New York & New Jersey Telephone	143½
Westinghouse Manufacturing Company	175

A special meeting of Consolidated Gas stockholders will be held on June 2, to vote on a proposition to issue $20,000,000 6 per cent debentures convertible into stock after three years. The stock will be issued to provide for "additional improvements and betterments, the acquisition of additional property, the payment of any indebtedness of the company, whether now existing or hereafter contracted." The stock will be issued to stockholders at par, payable in three instalments, of 30 per cent, 30 per cent and 40 per cent.

The directors of the General Electric Company have declared a regular quarterly dividend of $2, payable July 15 to stock of record June 15. Books do not close. The directors of the company have also voted to offer stockholders of record June 15 the right to subscribe for the new stock at par, on the basis of one new share for each ten of the old stock. Subscriptions will be closed July 15, and payments must be made on or before July 20.

Boston:	*Closing.*
American Telephone and Telegraph	124½
Edison Electric Illuminating	235
Massachusetts Electric	69½
New England Telephone	121
Western Telephone and Telegraph preferred	77

The American Telephone and Telegraph Company's statement of output of instruments for the month of April shows a net output of 60,572, bringing the total number of instruments outstanding for the first time in the company's history above the 4,000,000 mark. The number outstanding on April 30 was 4,032,667, which compares with 3,779,517 outstanding at the close of 1903.

It is stated that the New England Telephone and Telegraph Company will probably issue additional stock this summer for new construction. The growth of the company's business, averaging about 15,000 new subscribers annually, requires in the neighborhood of $2,000,000 each year for this purpose. For the first three months of this year there were 4,000 new subscribers added, making the total number March 31, 130,138. The last stock was issued in June, 1902, stockholders being offered 36,047 new shares at par on the basis of one new share for each five owned.

Philadelphia:	*Closing.*
Electric Company of America	8⅛
Electric Storage Battery common	55
Electric Storage Battery preferred	55
Philadelphia Electric	5⅛
Union Traction	49¾
United Gas Improvement	82

Philadelphia Electric Company directors have declared the regular semi-annual dividend of 2½ per cent, payable June 15. Books will remain closed from May 20 to June 17.

Chicago:	*Closing.*
Chicago Telephone	114
Chicago Edison Light	144
Metropolitan Elevated preferred	46¼
National Carbon common	30⅛
National Carbon preferred	102
Union Traction common	5½
Union Traction preferred	29

ELECTRIC LIGHTING.

ST. CLOUD, MINN.—It is stated that work on the proposed dam at Watah will be begun at once.

CLINTON, LA.—Work has been commenced on the new electric plant and waterworks, to cost about $10,000.

ETNA, CAL.—A survey is being made from Fort Jones to connect the Siskiyou electric power plant with Etna.

BETHLEHEM, PA.—The Bethlehem Electric Light Company has been awarded a five-year contract for lighting the city streets.

NYACK, N. Y.—Announcement is made of the consolidation of the Nyack Gas Light and Fuel Company and the Rockland Light and Power Company.

FARMER, N. Y.—The contract for lighting the streets of the village by electricity has been signed and the work will be pushed as rapidly as possible.

ESCONDIDO, CAL.—John Johnston, Jr., has applied for a fifty-year franchise to erect poles and place wires for electric lighting purposes throughout the city.

ANTIGO, WIS.—Fire recently destroyed the station of the Antigo Electric Light and Power Company. The loss of machinery was total, and is estimated at $20,000.

SPRINGFIELD, MASS.—The United Electric Light Company has made additions to its Indian Orchard plant which will increase its capacity from 2,850 to 3,800 horse-power.

DOVER, DEL.—The improvements to Dover's electric light and water plant, which were recently ordered, are now under way, and when completed will have cost about $12,000.

BUTLER, PA.—Citizens of Harmony, Zelienople and Evans City are contemplating the erection of a light and power-house at Eideneau station, midway between the three towns.

LITTLE ROCK, ARK.—A brick electric light and waterworks building combined is being erected at Brinkley by J. J. Ferrell, at a cost of $40,000. Mr. Ferrell has a fifty-year franchise.

DALLAS, ORE.—M. D. Ellis has sold the Dallas electric light plant to J. G. Van Orsdel for $8,500. It is stated that the new owner will improve the plant at an outlay of several thousand dollars.

BALTIMORE, MD.—The board of awards has awarded the contract to supply lights in Druid Hill Park to the United Electric Light and Power Company. The total amount of the contract will be $7,979.60.

MINEOLA, N. Y.—The Nassau Light and Power Company has been granted permission by the supervisor of Nassau County, to lay pipes and erect poles and wires on all county roads lying within the town of Hempstead.

WEST CHESTER, PA.—It is reported that the Ridley Creek Supply Company has purchased the water rights owned by the late John G. Smedley, and will erect a power plant to furnish electricity to Malvern, Paoli and Duffryn Mawr.

LOS ANGELES, CAL.—The linemen engaged in stringing the wires of the Kern River Power Company have completed the work beyond Newhall, and it is thought that the line will be completed to Los Angeles within three months.

SALT LAKE CITY, UTAH—The Utah Light and Railway Company is soon to establish a substation near the centre of the city, and will have it in operation by fall. The purpose of the station is the betterment of the electric lighting and power supply.

BALTIMORE, MD.—The Maryland Telephone and Telegraph Company will pay one and three-fourths per cent on the gross receipts of its electric lighting and power business as a franchise tax to the city for its right to use the streets and subways for supplying power.

FREMONT, NEB.—The annual report of the municipal light plant shows the total receipts to have been $12,372.79, and the expenditures $10,689.74, a cash gain of $1,683.05. There are now ninety-eight arc lights in service, and 6,000 sixteen-candle-power incandescent lamps.

EUGENE, ORE.—The large electric light and power plant of the Lane County Electric Company, at Springfield, has been placed in operation. Eventually the company has in mind the lighting of the road between Eugene and Springfield, and will soon commence a twenty-four-hour service.

ALAMEDA, CAL.—The city trustees have decided to operate the municipal electric light plant during the day for the purpose of supplying power for commercial purposes. It was reported that it would cost $2,500 to install the necessary wires, transformers and poles for the power system.

STILLWATER, MINN.—The Western Gas and Investment Company, of Chicago, owner of the gas and electric lighting plants in this city, is receiving machinery for a new power plant at Apple river falls, and will have the electric light and power line to this city in operation by the middle of July.

PITTSTON, PA.—The stockholders of the Citizens' Electric Illuminating Company have elected the following directors: M. W. O'Boyle, K. J. Ross, Thomas Mangam, Joseph Langford, A. B. Brown, J. H. Glennon, J. L. Cake. The only change was the election of M. W. O'Boyle to succeed the late B. J. Durkan.

MEDINA, N. Y.—The first penstock and wheel have been installed at the big dam of the Sweet Power Company and found to work in a perfectly satisfactory manner. Work will be pushed all summer on the dam and other improvements, and meantime the two remaining penstocks will be put in and turbines will be ready by the time the full water power has been developed.

DENVER, COL.—It is stated that eastern capitalists are negotiating for the purchase of the Green mountain falls water system, on Catamount creek, west of Manitou. If an agreement is reached, it is probable that a large power station and storage reservoirs will be constructed this summer. The main dam, if built, will be placed just above the falls on Catamount creek. Within one-half mile of the falls there is a fall of 1,200 feet.

ST. LOUIS, MO.—Plans for the establishment of a municipal lighting plant at the house of refuge are being considered by the board of public improvements. The plant, as contemplated, is to illuminate the territory from the river to the city limits, south of Keokuk street, by electricity. At present that section is lighted with gas at an annual cost of $60,000. It is stated that the city can establish its plant and get the first cost of construction back inside of four years.

NEW CASTLE, PA.—It is stated that all thought of a municipal light plant has been abandoned, because of an agreement reached between the city and the New Castle Electric Company. By the terms of this agreement, the city shall, for the next eight years, pay $75 annually for 200 arc lights, and $70 for all over 200, a lump sum of $30,000 being paid for light since July 31, 1900. The electric company, at the end of the eight-year contract, is to waive any right to a perpetual street lighting franchise.

TROY, N. Y.—At the annual meeting of the Hoosick Falls Electric Company the following board of directors was elected for the ensuing year: W. H. Tylee, Frank H. Viele, Worcester, Mass.; Derick L. Hall, Ralph D. Smith, Hoosick Falls; James Henry, Corning. The board of directors elected Frank H. Viele, president; Derick L. Hall, vice-president; W. H. Tylee, secretary and treasurer, and Ralph D. Smith, general manager. It was decided to commence the work of rebuilding the dam at the power station immediately.

DUNKIRK, N. Y.—Dr. D. G. Pickett, of Fredonia, who owns the riparian rights of the Canadaway creek above Laona, and purposes to supply Dunkirk and Fredonia with power, has now purchased the riparian rights at State Line Gulf, near the line between New York and Pennsylvania. His plans are to build a dam across the gulf with a fall of 300 feet, generating electricity sufficient to operate the trolley line between North East and Westfield. It is stated that the volume of water is sufficient for this purpose during the dryest season.

LEGAL NOTE.

TUBULAR DROP SUIT DECISION—ON May 3, 1904, in the United States Circuit Court of Appeals, for the sixth circuit, in the case of the Western Electrical Company *vs.* the Northern Electric Company, *et al.*, an opinion was handed down in the Warner tubular drop suit finding that the defendant, the Northern Electric Company, does not infringe the apparatus of the company. A decree dismissing the bill was therefore affirmed.

TELEPHONE AND TELEGRAPH.

JOPLIN, MO.—The Bell Telephone Company is erecting a line to Duenweg.

LE MARS, IOWA—The Independent Telephone Company will build a line to Merrill.

READING, PA.—The Bell Telephone Company is surveying for a new line from Windsor Castle to Kempton.

ELKHART, IOWA—The Elkhart Mutual Telephone Company has been incorporated with $10,000 capital stock.

SPRINGFIELD, MASS.—Work has been begun on the telephone line which is to run from Russell to Montgomery.

LEBANON, N. H.—A telephone line is to be built from Hanover Center to Lebanon, making connection with the New England line.

BAY CITY, MICH.—The Michigan Telephone Company is building a line from Freelands, in Saginaw County, to Laporte, Midland County.

FORTVILLE, IND.—A new telephone plant has been installed here. Long-distance connections will be had through the Central Union company.

SALT LAKE CITY, UTAH—The Rocky Mountain Bell Telephone Company is putting in a new line from the Cactus mine to Newhouse, in Beaver County.

FRANKLIN FALLS, N. H.—The Citizens' Telephone Company has been granted a franchise to run its line to Northfield Centre and the Zion Hill district.

STERLING, ILL.—A telephone line is to be constructed between the towns of Harmon and Sublette, connecting with the Farmers' Telephone Company at Amboy.

BOULDER, COL.—The city council has granted a franchise to the independent company which is operating in Greeley, Fort Morgan and other cities of the state.

SACRAMENTO, CAL.—Albert Gallatin, Jr., R. O. Snelling and others have formed a corporation under the name of the Red Bluff & Paskenta Telephone Company.

PENFIELD, N. Y.—The Bell Telephone Company is installing a new line from Penfield village to Kennedy's Corners, thence east to the Dublin road and south to Fairport.

PORT CLINTON, OHIO—The Ottawa County Telephone Company is putting in a new switchboard at this place which will enable the company to reach over a thousand customers.

BATAVIA, N. Y.—The board of trustees has granted a fifty-year franchise to the Bell Telephone Company, on the condition that the company supply telephone service to the town to the extent of $250.

LEESBURG, VA.—The Snickersville Telephone Company has established a long-distance line throughout the county of Loudoun, connecting with lines to Baltimore, Washington and Philadelphia.

CORVALLIS, ORE.—A franchise has been secured and articles of incorporation have been filed by the Corvallis Independent Telephone Company, which is preparing to install its system in this town.

LEONARD, N. D.—A telephone company has been incorporated with Richard Piper as president. It is building forty miles of line extending north from this place, taking in Lynchburg, Everest and Davenport.

MONUMENT, COL.—The Farmers' Western Union Telephone Company, which was recently organized, has extended its line to this town, enabling communication to be had with Elbert and Eastonville.

RICHFIELD SPRINGS, N. Y.—A company has been organized at West Exeter for the purpose of installing a line from West Exeter to West Winfield. J. H. Watkins was elected president and D. L. McLaughlin secretary and treasurer.

MANCHESTER, N. Y.—At the annual meeting of the stockholders of the Red Jacket Telephone Company, of this place, the following officers were elected: president and general manager, Carlos P. Osgood; vice-president, R. B. Peck; secretary, W. C. Ellis; treasurer, O. S. Titus.

NEW YORK, N. Y.—The annual meeting of the Mexican Telephone Company was held in this city on May 11, when C. H. Rollins was reelected president, and W. French Smith secretary of the company. The report of the treasurer showed the company to be in a prosperous condition financially.

DELPHI, IND.—The new cooperative telephone company organized in this county will be known as the Flora & Bringhurst Cooperative Telephone Company. The officers are: president, W. E. Callane; secretary, A. G. Crosswhite; general manager, E. E. Eikenberry; treasurer, J. H. Coplen.

UTICA, N. Y.—In order to accommodate increasing patronage, the Utica Home Telephone Company will make an extension to its main switchboard which will accommodate 500 additional connections. Since April 1 of last year the number of telephones in operation has increased from 1,300 to 2,800.

ELMIRA, N. Y.—A company has been organized for the purpose of constructing a telephone line between Coopers Plains and Hornby, connecting with the New Century and Bell systems at Watkins. The officers are: president, Isaac Rising; vice-president, William Duvall; secretary and treasurer, Miles Woodard.

MARIETTA, OHIO—William Wendell, John B. Eck, H. J. Hoffer, Frank Wolfram, C. E. Rechsteiner, F. A. Rieman and C. G. Snider are projecting a company which has for its object the establishment of an independent telephone exchange in Lowell. The line will be extended to Beverly and Caldwell, from which places direct communication may be had with all the leading cities of the state.

WHEELING, W. VA.—A contract has been signed between the National Telephone Company, which has its headquarters and principal lines in this city, and the United States Independent Long-Distance Telephone Company, by which the local company will have connection with all of the principal points of Ohio and Indiana. The contract provides that all the work required is to be finished by the first of July.

AUTOMOBILE NOTE.

ST. LOUIS RUN OF THE AMERICAN AUTOMOBILE ASSOCIATION.—The special committee, having in charge the tour of the American Automobile Association to the St. Louis Exposition, July 25 to August 10, 1904, reports steady progress made in settling numerous details of the tour. The chairman of the committee, Mr. Augustus Post, has been investigating the road conditions and making contracts and arrangements on the national highway between St. Louis and Columbus, Ohio. Mr. Post will make a report on the roads, on the garages engaged, hotels, etc., on his return to New York shortly. Mr. Frank X. Mudd, chairman of the Chicago committee, has recently gone over the road between Chicago and Joliet, by way of the Illinois river. He reports that this has been made an optional route, in case it is shown that the road as planned is less desirable than the river road. Mr. Mudd also reports that he went over the route from Springfield to St. Louis recently with Mr. Post and found the roads, although rough, in good condition. He states that the tourists in August will have no trouble on the road from Chicago to St. Louis except from dust. Colonel R. D. Loose, the committeeman from Springfield, Ill., has rented the Dome Building at the State Fair Grounds, Springfield, as a garage for the participants in the tour, to be used on Friday, August 9. It is claimed that this building is the largest domed building in existence. It will accommodate readily the entire contingent. The road commissioners of Fayetteville, N. Y., have notified local representatives of the touring committee that they will make special repairs on the road between Fayetteville and Syracuse, just before the tour. There are indications of similar intentions on the part of road officials at other points along the main line. Investigations made by Secretary S. M. Butler, of the Automobile Club of America, of the roads to Gettysburg have proved that a change of route between Philadelphia and Gettysburg will be necessary. The committee has taken up this matter and it is reasonably certain that the itinerary for this portion of the Philadelphia-Pittsburg division will be changed. Instead of going through York and Lancaster, the tourists will run from Philadelphia to Reading and Harrisburg and thence to Gettysburg. This will give uniformly better roads and more satisfactory running conditions. The office of the St. Louis tour committee is at room 612, 31 West Forty-second street, New York city, N. Y.

INDUSTRIAL ITEMS.

THE BULLOCK ELECTRIC MANUFACTURING COMPANY, Cincinnati, Ohio, announces that it has moved its New York offices to the Empire Building, 71 Broadway. Mr. E. W. Goldschmidt is the district manager at this headquarters.

THE CROCKER-WHEELER COMPANY, Ampere, N. J., has just issued a booklet containing a reprinted article on "The Government Printing Office." This printing office, which is one of the largest in the world, has a very complete electrical equipment which is of the Crocker-Wheeler manufacture.

THE ELECTRIC APPLIANCE COMPANY, Chicago, Ill., general western agent for Packard "Zenith" lamps, is experiencing a decided rush in filling orders for lamps for decorating dining rooms, pavilions and porches at summer resorts. The company has special circulars on this subject which it will be pleased to mail upon request.

THE NATIONAL CONDUIT AND CABLE COMPANY, 41 Park Row, New York city, N. Y., manufacturer of bare copper wire, weatherproof wires and cables, and lead-covered wires and cables for telephone, telegraph, electric light and power work, has issued its May copy of "Copper Gossip." This leaflet contains interesting information in connection with the copper market, etc. Leaflets will be sent upon request.

"THE FOUR-TRACK NEWS," published by the passenger department of the New York Central & Hudson River Railway Company, for June, is worth taking up and studying. The table of contents is extremely varied and there includes in all fifty articles. Among other articles are "The Study of Nations," by Emma Archer Osborne; "The Path of Empire," by Thomas H. Davies, and "The Orient at St. Louis," by Charles P. Wells.

THE ELECTRIC STORAGE BATTERY COMPANY, Philadelphia, Pa., has taken a residence at 4472 Forest Park boulevard, St. Louis, Mo., for the use of members of its staff attending the Louisiana Purchase Exposition. The company's exhibit, which is one of the largest and most comprehensive that has ever been made by a storage battery company, is practically complete. It contains many interesting features, showing the recent developments in storage battery practice.

THE H. T. PAISTE COMPANY, Philadelphia, Pa., is distributing a neat advertising folio calling attention to its "Pushin" attachment plug. This attachment plug is made so that it is not necessary to screw the plug in, twisting the cord in so doing. To insert the plug, it is merely thrust into the socket and is held fast. Two corrugated lugs on the sides hold it in place, while a contact at the bottom completes the connection. To take the plug out, it is given a slight backward twist, or simply pulled out. The former way is better and easier.

THE COLUMBIA INCANDESCENT LAMP COMPANY, 2115 Locust street, St. Louis, Mo., is distributing a great deal of interesting literature concerning the Columbia product. Columbia lamps are at the present time very popular, and the company claims this is due to the extreme care with which the different processing is carried out. The company has branch offices, where lamps are carried in stock, at New York, 1311 Havemeyer Building; Minneapolis, 248 Hennepin avenue; Chicago, Central Electric Company; San Francisco, 406 Market street; Philadelphia, 1227 Real Estate Trust Building; Memphis, 35 Equitable Building.

THE EDISON ELECTRIC ILLUMINATING COMPANY, 360 Pearl street, Brooklyn, N. Y., has issued the May copy of the *Brookyln Edison*. This issue as usual contains many interesting articles and illustrations, among which are: "Temporary Lighting for Decorative Effect"; "As to the Advertising Value of the Electric Sign—Expert Testimony"; "Our Dreamland Pictures"; "A 10,000-Horse-Power Turbine for the Brooklyn Edison Company," etc. On the front cover is a half-tone engraving of "An Old Street Recently Enlivened by Electric Signs," and many other interesting half-tones are distributed throughout the publication. Copies of the *Brooklyn Edison* will be sent on request.

THE HAZARD MANUFACTURING COMPANY announces that beginning with May 1 the sale of its wire rope product in Chicago and western territory was brought under its own management. This company has established its offices and warehouse at 71 and 73 West Adams street. Mr. Robert A. Peet has been made sales agent of the Hazard company's entire product in Chicago and western territory. Mr. Peet for the past three years has had charge of the sale of the insulated wires and cables manufactured by the Hazard company. Mr. Homer A. Wessel, Jr., has been sent from the works at Wilkesbarre as assistant to Mr. Peet. A large and complete stock of wire rope and wire rope fastenings and fixtures will be carried in this warehouse, as will also a stock of single and double galvanized strand of ordinary and special strengths.

THE WESTINGHOUSE COMPANIES have published an interesting and instructive folio concerning features of interest with regard to the St. Louis Exposition. There is a map in colors of the city of St. Louis, showing the locations of the principal hotels, principal clubs and societies, prominent restaurants in addition to the hotels and clubs, and principal theatres and gardens. There is also an index showing where some typical Westinghouse installations are located in St. Louis. An index to the exhibits at the World's Fair is also of interest and value and there is also a key to the Westinghouse features of the exposition. The principal Westinghouse exhibits are in the machinery and transportation and the electricity and machinery buildings. The exhibit area, excluding the service plant, covers 39,000 square feet. The exhibit area, including the service plant, covers 66,000 square feet. The Westinghouse Companies' headquarters and joint exhibit are in the Machinery Building, just south of the service plant.

THE DUNCAN ELECTRIC MANUFACTURING COMPANY, La Fayette, Ind., will be pleased to send its illustrated bulletin describing the Duncan integrating wattmeter for direct currents. This meter contains a new means of compensating for friction and vibration on light loads, consisting of a small multi-point switch in connection with a compensator coil secured to the back of the meter between the series field coil and the magnets. By moving the switch arm over the contacts any desired degree of compensation can be secured. A visual bearing permits of the lower end of the shaft or spindle points and the jewel bearing being inspected while the meter is in operation. The meter has a hollow nickel-steel spindle, a large direct-reading porcelain dial, artificially aged magnets and commutator, and an aluminum retarding disc provided with a split hub. The meters are finished in nickel, dull black, polished brass or antique copper, and are furnished with sheet metal cases having glass windows. The meters may be furnished to read in dollars and cents for different rates, or kilowatt-hours, and also to read in Board of Trade units and horse-power-hours.

OBITUARY NOTICE.

MR. WILLIAM WALLACE, who was born at Manchester, England, March 16, 1825, died May 20, 1904. His funeral was held at the home of his sister, Mrs. Wooster, at Ansonia, Ct., on Monday, May 23, 1904. Mr. Wallace, who was one of the early investigators into matters electrical, started to work in the Howe Pin Company, Birmingham, Ct., in 1841. In 1846 he entered into the manufacture of brass and brass wire on his own account with his sons, under the name of Wallace & Sons, at Birmingham, and two years later moved his factory to Ansonia, Ct. In 1853 the company was changed from a partnership to a corporation, retaining the old name of Wallace & Sons. The company then manufactured wire for electric lighting and power purposes and made a specialty of feeder and trolley wire, copper rivets and specialties of brass. In this period Mr. Wallace devoted much time and thought to electric lighting, but in 1880 was taken seriously sick and was forced to temporarily give up his work. Mr. Wallace was among the scientific men who assembled at Philadelphia, Pa., in 1876 to witness the first public exhibition of the "Bell" telephone. Mr. Wallace was also one of the pioneers in the construction of dynamo-electric machinery, and in 1875 his company commenced to manufacture dynamo-electric machinery. One of the important projects carried out by Mr. Wallace was the construction of an electro-deposition plant in conjunction with his brother Thomas. In a series of articles written in the *Electrical Engineer* of February 1, 8, 15 and 22, 1893, by Mr. William J. Hammer, Mr. Wallace is credited with having invented and constructed the first arc lamp made in this country. He was a member of the American Institute of Electrical Engineers, of the American Society of Mechanical Engineers, of the American Society for the Advancement of Science, and of many other scientific organizations.